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*THE UNIVERSITIES IN RELATION TO RESEARCH.**

IT is now many years since I came to the conclusion that the provision of adequate facilities for research is one of the prime necessities of university education in Canada; and it is with the object of accelerating the movement which has already begun in this direction that I have selected the relation of the universities to research as the topic of my remarks on this occasion.

It will perhaps be expedient for me at the outset to say that I propose to use the word research in its widest meaning, *i. e.*, as indicating those efforts of the human mind which result in the extension of knowledge, whether such efforts are exerted in the field of literature, of science or of art. It is a common mistake to apply the term research to what we somewhat erroneously denominate as 'science,' meaning thereby the physical and natural sciences. This limitation is comparatively modern, and science so defined is after all only a part of human knowledge.

The limits of research in its wider sense are coterminous with the knowable, and research itself is of very ancient date. The fund of knowledge accumulated even before the Christian era was enormous. This great fund, however, remained stationary,

* Address of the President of the Royal Society of Canada at the Toronto Meeting, May 27, 1902.

or nearly so, throughout the Dark and and Middle Ages. During this period of mental stagnation, authority was the watchword of the learned. All knowledge was supposed to have been already discovered, and the efforts of the schoolmen were devoted to the application of this body of truth to life and conduct. This mediæval point of view has been quaintly and aptly put by Chaucer:

Out of olde feldies, as man saieth,
Comith all this newe corne from yere to yearn;
And out of olde bokis, in good faithe,
Comith all this newe science that menne learn.

With the Renaissance began a new epoch, an epoch in the midst of which we are still living. It marked, as has been well said, 'the liberation of the reason from a dungeon, the double discovery of the outer and inner world.' The study of the humanities, which was an incident of the Renaissance, rendered available to modern men the wisdom of the ancients. But much of the old knowledge was found to be spurious when examined with the new light, and even the authority of Aristotle, the demigod of the scholastics, was discredited. Nothing henceforth was to be accepted on trust, and the injunction to 'prove all things' became the watchword of the learned.

Although the Renaissance marked the regeneration of philosophy, of criticism, and in general of the whole process of thought, it especially denoted the birth of the physical and natural sciences, and hence their rise and progress may be taken as best illustrating the working of the new spirit of research. Roger Bacon in the thirteenth century protested vainly against the despotism of Aristotle, and advocated a new and fruitful learning which should be based upon experience. In the two centuries which followed, those scholars described by Whewell as the 'Practical Reformers,' working in their primitive laboratories, established a sound basis for a future natural philosophy. One of these, Leonardo da Vinci (1452–1519), both a practical and a theoretical philosopher, anticipated modern science in his remark: "The interpreter of the artifices of nature is experience, who is never deceived. We must begin from experiment and try to discover the reason." Telesio (1508–1588), called by Francis Bacon 'primus hominum novorum,' said: "The construction of the world and the magnitude and nature of the bodies in it are not to be investigated by reasoning, as was done by the ancients; but they are to be apprehended by the sense and collected from the things themselves." These were some, but not nearly all, of the forerunners of Francis Bacon (1561–1626) who by his writings, and especially by his 'Novum Organum,' elaborated in detail a method of research, the principles of which had been laid down by his predecessors.

From the overturning of the authority of Aristotle and the laying down of a secure basis for the advancement of knowledge, it was but a step to the inauguration of organized research, the aspect of the question to which I wish to invite your attention somewhat more in detail.

The chief agencies of modern organized research are (1) the learned societies and (2) the universities. The former receive and publish research papers; the latter superintend and direct investigators and publish results. To these should properly be added the various journals which have been established and carried on by private effort. It is a significant fact that the establishment of modern learned societies coincides closely in time with the Renaissance movement. Telesio, mentioned above, established one of the earliest mathematico-physical societies—the Academy of Cosenza. Other Italian societies of similar scope were founded in Rome in 1603, in

Florence in 1657, and the Royal Society of London dates from 1660 or earlier. Organized research in universities was of slower growth. In them the mediæval spirit was tenacious of life, and it was only in the nineteenth century, in Germany, at the close of the Napoleonic wars, that research, not only in natural philosophy, but in the whole field of knowledge, became the basis of the German educational system, and I might remark, without going into details, that the university systems of France and the other principal countries of Europe, with the exception of Great Britain, are in the main parallel with that of Germany, although not so consistently elaborated. To understand then what organized university research means in the fullest development which it has hitherto attained, let us turn our attention a little to Germany, of the educational system of which it forms an essential part.

We are so subject to the authority of words that it is difficult for us to realize that the organization called a university in Germany is almost entirely different in scope and object from the institution which we so designate in this country. Hitherto, at least in England and Canada, the function of the university has mainly been to impart a general and liberal education, continuing and completing the beginning already made in the secondary school. Speaking generally, I may say that under the German system the work of our secondary schools and universities combined is performed by the gymnasium, the nine or ten years' training of which leaves the young man of nineteen or twenty years of age with a much better liberal education than that possessed by the average graduate in arts of an English, Canadian or American university. How this is accomplished it is not my purpose here to explain. There is no doubt, however, as to the fact, which is substantiated both by the nature of the curriculum of the gymnasium and by the testimony of those familiar with both systems. In this connection I recall the observation made to me on one occasion by a professor here, himself a wrangler of high standing in Cambridge, who remarked that it was always a mystery to him how the German gymnasiums attained such extraordinary results, results which, he added, it would be hopeless to expect in England, while on the other hand I have more than once heard German professors express surprise at the meager equipment of university graduates from America.

It is upon this substantial preliminary training that the work of the German university proper is based. Up to this point the young man has been a 'learner'; on entering the university he becomes a 'student.' This distinction, expressed by the German words 'lernen' and 'studieren,' marks the difference between gymnasium and university—the acquisition of knowledge under the teacher in one, the independent research under the guidance of the professor in the other.

The typical German university possesses the four faculties of theology, law, medicine and philosophy. The scope of the first three is evident from their designation, and with them we are not at present immediately concerned. The faculty of philosophy embraces the subjects which we include as university studies, under the head of arts and science. It is the most important of the four, the professors in it sometimes outnumbering those of all other faculties combined. The ultimate object of both professors and students is the advancement of knowledge and the independence with which research is conducted is well expressed by the two words 'Lehrfreiheit' and 'Lernfreiheit'—the freedom of the professor as to what he teaches and the freedom of the student to select his special line of research. Some idea of the

extent of this work may be formed from the number of universities in Germany, 21 in all, and from the fact that the aggregate number of matriculated students exceeds 12,000, in addition to non-matriculated students, who are also numbered by thousands, while the philosophical faculty at Berlin and Leipzig in 1901–2 numbered, respectively, 207 and 120. To the 21 universities mentioned should be added the nine technische Hochschulen which have now the right to confer the doctor's degree in the applied sciences.

It is impossible to exaggerate the enthusiasm which prevails among both professors and students in their common object, and this enthusiasm is increased by legitimate emulation. The reputation of a university depends upon the progress made by its professors, the reputation of a professor upon the progress made in his department. Hence a student may be attracted from one university to another—which is allowable under the system—may choose to follow the lectures of the professor, ordinary or extraordinary, or even those of the privat-docent in his own particular line of work. Under such a system and under such stimulating conditions it is evident that both professors and students must take their work seriously, with the result that the combined effort of a vast number of the best minds in the country is concentrated on the advancement of all the principal branches of knowledge. With regard to the research work done by the student and without which the degree of Ph.D. is not conferred, it may be objected that much of it is not important and sometimes very trivial. It may be said, however, that it must all stand the test of publication after being approved by the professor, so that its value may at once be estimated by the learned world, and the scholastic standing of professor and student rated accordingly.

The place and importance of research in the German system is further indicated by the fact that even teachers in the gymnasium devote themselves to such work, their papers being published in the annual reports of their institutions. With such respect is the ability for research regarded that the publication of a paper of this kind may lead directly to a professorship in the university, as was the case, for instance, in the appointment of Weierstrass, the celebrated mathematician.

Let us now turn our attention for a few moments to the British university system. An extended description is unnecessary, since we are all familiar with the working of British universities themselves, or with the Canadian or American development of the original British type. Hence it may suffice if I contrast briefly the British and German systems in some of their essential features.

In the organization of the German university research has been shown to be a fundamental principle; in the British university it is as yet incidental or of sporadic manifestation. I do not of course ignore the very important contributions which have been made by British scholars to the advancement of learning, but it is worthy of note that the credit for their splendid achievements is rather due to the individuals themselves than to the universities with which many of them were connected. The British university is not primarily an institution for research. In its function of providing the higher grades of a liberal education the proper comparison is with the upper classes of the German gymnasium, not with the German university proper. True, we find in some of the British universities a specialization in certain subjects, *e. g.*, in honor classics and mathematics at Oxford and Cambridge leading to higher work than that attempted in the gymnasium; but however advanced

the studies may be, there is rarely any attempt to guide the English undergraduate in the direction of research. Reading and examinations are the academic watchwords, and to the great mass of students and tutors the field of research is a terra incognita.

The attitude of the British nation has been hitherto largely that of indifference towards organized research, and this has been true not only of the general public, but also of those engaged in academic administration. There has existed a deep-seated conviction, born perhaps of reiterated assertion, that the British university system is superior to that of Germany or any other country, and as near perfection as may well be. We are not concerned just here with the discussion of the merits of the system, which are undoubtedly many and great, but we must admit that the attitude of self-satisfaction which has prevailed, combined with the ignoring of other ideals, is at least unphilosophic. In the midst of such an atmosphere it is not surprising that the development of a true Renaissance spirit has been somewhat tardy.

But the British nation is on the eve of an awakening, an awakening which has already taken place among certain leaders of thought. The fact is dawning upon the British mind that some vital connection really does exist between national progress and scientific discovery, and that the latter should be fostered in connection with the higher institutions of learning. Under the conviction that British commercial supremacy will be seriously threatened unless foreign, and especially German, scientific methods are adopted, universities of more modern type than Oxford and Cambridge, and also technical colleges, have been established. Such institutions no doubt fill a long-felt want, but they do not go to the root of the matter. On the academic side they are but a modification of the older type; on the technical side they contemplate, not the discovery of new truth, but the application of what is already known. The spirit of research is lacking, and without it no expenditure of money, no raising of examination standards for mere acquirement, will actually increase the capital account of national knowledge.

It is perhaps owing in part to the general awakening already mentioned that a rudimentary scheme of research has been recently introduced in the University of Cambridge, where students pursuing original investigations are placed on the same level as the ordinary undergraduate and may obtain the B.A. degree as a reward for work of this kind. Notwithstanding the lack of more substantial encouragement a number of students have entered these courses, being attracted by the reputation of certain professors who are themselves zealously engaged in the prosecution of research. The number of such students, however, is relatively small, nor can it be said that the movement has become general, although other universities are beginning to do something in this direction, but it may perhaps prove to be the germ of a more complete organization in the future.

The policy of the universities of the United States regarding this matter is in marked contrast with the indecision and conservatism which prevail in the mother country. The type of mind which has been developed in the century and a quarter of separate national existence is one of great vigor and originality; but these qualities have for the most part been turned aside by the circumstances of a new country from abstract investigations. Research after the almighty dollar by the nearest short-cut has been, and perhaps still is, regarded as the chief national characteristic of our American cousins, and in this pursuit they have displayed a genius

for concrete research in mechanical invention and an ability for commercial and industrial enterprise which have been an object of wonder, and latterly of anxiety to other nations. During the first hundred years of national existence the university of the gymnasium type which has been inherited from England continued to develop and expand in the United States. Suddenly, however, almost exactly twenty-five years ago, a remarkable modification was introduced. The year 1877 marks an epoch in the establishment of the Johns Hopkins University, with research courses leading to the degree of Ph.D. as an addition to the usual undergraduate work; in other words, a grafting of the German university system upon the original stock. It is proper to state that even before that date research work had been prosecuted incidentally in some of the older existing universities. On consideration of the circumstances it is not difficult to account for this new departure. The movement was undoubtedly due to the influence of American students who had gone to Germany for special studies. This migration to and fro had been going on for some time before the founding of Johns Hopkins and still continues, the number of such students gradually increasing from 77 in 1860 to an average of about 400 annually during the last decade. The new university experiment was a success from the first. The scheme was carried out on such a high plane that large numbers of able and zealous students were attracted from all parts of the continent by the facilities for higher study and by the scholarships and fellowships which formed part of the scheme. The appointment of graduates of Johns Hopkins to positions in other universities and their success as teachers and investigators have led to a widespread demand for professors who have proved their capacity for original work.

Since 1877 many other universities, including the best of those already in operation, as well as new foundations, have added a graduate department leading to the Ph.D. degree, although none of these, with the exception of Clark University, has made the prosecution of research the sole business of the university. Some idea of the rapid progress of this movement may be gathered from the fact that the numbers pursuing graduate studies in the universities of the United States have increased from eight, in 1850, to 399 in 1875, and to about 6,000 in 1902. We must conclude from these figures, I think, either that the national mind discerns some ultimate advantage in the cultivation of abstract science, or that, for once, it has been mysteriously diverted from the pursuit of the 'main chance.' It is surely significant that a practical philanthropist like Mr. Carnegie has recently bestowed the magnificent endowment of $10,000,000 for the establishment of an institution to be devoted solely to the promotion of research.

As to the ultimate scientific value of what has already been accomplished in the way of research under the influence of this recent movement, there is room for a qualifying remark. It must be remembered that much of the graduate work referred to does not mean actual research, the course for the Ph.D. in many cases being no higher than the honor B.A. course with us. What is required to remedy this unsatisfactory condition is that the Ph.D. be given only on the German plan, and that the main test therefor, a research, be published. When this condition becomes absolute there will be material for the world's judgment as to the amount and quality of the contribution to the advancement of knowledge.

Organized research in Canadian universities, as a definite system, can scarcely be said to exist as yet, although within the

last decade certain beginnings have been made which indicate a movement in that direction. Canada, like the United States, has derived its university ideals from Great Britain. Some of the original faculties of our universities were a transplantation, so to speak, of groups of scholars from Britain, who brought with them intact the traditions in which they themselves had been nurtured, so that we received by direct importation scarcely more than fifty years ago a system which in the United States had been developing in its own way since the founding of Harvard in 1636. I cannot better illustrate the attitude towards research of many of these academic pioneers than by quoting the remark made by an English professor—himself a classical scholar—on an occasion so comparatively recent as the establishment of the physical laboratory in the University of Toronto. 'Why go to the expense,' said he 'of purchasing this elaborate equipment until the physicists have made an end of making discoveries?'

In the interval the idea of research has made gratifying progress among the well-informed. Probably few scholars could now be found in Canada who would put their objections so naïvely as my classical friend. This progress has come in part from a natural process of evolution within ourselves, and in part also from external influences, notably that of Germany and the United States. Many of our graduates have pursued courses of study in Germany and have brought back with them the German ideal. Besides, such is the geographical position of Canada with regard to the United States, and such the community of social and intellectual life, that the universities of these two countries must inevitably develop along parallel lines; and hence, if for no other reason, we may look forward to the gradual extension here of the research movement which is already so widespread in the neighboring republic.

That a natural and healthy demand for this kind of work already exists may, I think, be inferred from the success which has attached to the recent establishment of the doctorate degrees in certain universities, but still more perhaps from the fact that for some years it has been customary in some cases to direct honor students in the final year of the B.A. course to the work of research. In illustration of what has been accomplished in this way I may state that some of the papers presented in Section III. at the present meeting have been prepared by undergraduates in arts in the University of Toronto. But whatever may be the ultimate outcome of the research movement with us, permit me to repeat what I have already said in another connection, namely, that the Ph.D. should not be given without the presentation of a satisfactory thesis, and that such research should be published before the degree is awarded.

I have confined my remarks up to this point almost wholly to the historical aspect of the question, but it will perhaps not be out of place for me to point out in conclusion some of the advantages which in my opinion are connected with the pursuit of university research.

Let us consider first the stimulating effect upon the individuals and institutions concerned. Among those who are affected by this stimulus should first be named the professor. Dr. Samuel Johnson was wont to compare accumulated knowledge to a heap of ice lying exposed to the summer sun, the bulk of which could not be maintained without constant replenishment. Continuing the figure, we can readily imagine that the professor's fund of knowledge which is ample enough for the classroom teaching of immature minds might

shrink and trickle away until little is left but the sawdust which we usually associate with the preservation of that commodity. Under the stimulus of research this is impossible, for research into the new implies a full and minute mastery of that branch of knowledge in which the research is being conducted. Hence if no other advantage resulted a good case might be made out along this line of argument.

This stimulus to the professor would react with increased force upon the student. It was a favorite saying of a certain celebrated artist that those who follow after others rarely outstrip them. To hold up before the student either by theory or practice solely the ideal of acquiring what has already been learned is mediævalism pure and simple; it is to teach him to creep where he might walk upright and alone; it is to rob him in part of that intellectual birthright of independent thought which is the inheritance of every man, at least since the Renaissance. It is sometimes objected that the results attained by research students are often trivial or futile. I am disposed, however, to agree with a remark made by one of George Eliot's characters: "Failure after long perseverance is much grander (and I would say parenthetically more useful) than never to have a striving good enough to be called a failure." It is sometimes also urged that research in the immature student leads to superficiality and conceit. I cannot but think this fear ill-grounded. It has been proved on the contrary that nothing will so quickly ripen and enlarge preliminary knowledge and so effectually extinguish presumption as the hand-to-hand struggle with some special problem in the department of study in which the student is already proficient.

Apart from the professor and student, the first effect of the inauguration of research work in our universities, if of the genuine stamp, will be felt upon the teaching profession of the country as a whole. Assuming an educated and interested public opinion, the premium so long placed upon memorized knowledge will disappear, and a change in the principle of selection of teachers both in universities and secondary schools will result. The time will have gone by, let us hope, when Huxley will be passed over, as was the case fifty years ago, when his candidature for a chair in the Provincial University was unsuccessful.

We come finally to the effect of research upon the national life. Canada, it is true, is barely on the threshold of national existence, rich, however, in natural resources, and richer still in the physical, moral and intellectual qualities of its people. Its future as a nation will depend largely upon the aggregate of intellectual effort of its population. In this sense truly knowledge is power. The time has surely come when we should cease to take all our knowledge at second hand from abroad, and when we should do some original thinking suitable to our own circumstances. Under the term original thinking I do not include merely the researches of the laboratory, for the spirit of research which inspires the chemist or the philologist is one with that creative faculty which moves the poet and the novelist, a spirit which guides all contemporary movements in literature, science and art. For the development of this spirit of originality the country must look primarily to its universities, for on them depends ultimately the whole intellectual life of the people. The time is approaching, if indeed it has not already arrived, when the research university must be regarded as the only university, and the task is incumbent upon those in authority of elaborating a university system not necessarily in imitation of those of other lands, but one which shall have proper regard to the

importance of this new factor as well as to the past and future of our country.

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SECTION OF THE GEOLOGICAL AND BIOLOGICAL SCIENCES.

THE meeting of the Royal Society of Canada at Toronto, May 26–29, was one of great interest, especially so in regard to the value and importance of the papers and discussions in Sections 3 and 4, whose particular province is the study of the natural and applied sciences. The meetings were held within the precincts of the University of Toronto, whose ample halls and well-equipped laboratories were placed freely at the disposal of the Society. The beautiful 'Queen City' of Canada was bright with blossoms and the fresh-tinted foliage of the trees which so abundantly adorn her broad avenues. A generous welcome was extended by her citizens to the fellows and delegates of the Society who represented Canada from Halifax to Winnipeg. The meeting lacked the genial presence and active inspiration of Sir John Bourinot, the honorary Secretary, whose serious illness was a matter of deep regret to all. His rare executive ability and tact, and the control which he has so wisely exercised in guiding the Society during the twenty perilous years of its existence, are shown in the position which it occupies to-day. The stimulus which it has given to original research and the world-wide interest which the publication of its proceedings has awakened have been in a large measure due to his fostering care and unremitting industry.

Among the recommendations contained in the report of the honorary Secretary were the following: That everything possible should be done to preserve historical sites in Canada; that systematic ethnological work should be carried on; that the Canadian people should cöoperate with the people of the United States and Mexico in determining the ninety-eighth meridian; and that the operations of the Government Marine Station of Biology should be continued and increased. During the meeting committees considered several of these recommendations and emphasized their importance in subsequent reports.

The address of the president, Dr. Loudon, of Toronto University, on 'Research in Universities,' was a careful presentation of the subject, showing what has been done—and what has not been done—in German, English, United States and Canadian Universities.

In Section 4 a large proportion of the papers read embraced topics on the geology of various sections of eastern Canada. One of the most important of these was a paper on the sites of ancient volcanic activity in the neighborhood of the St. Lawrence Valley, by Professor Frank D. Adams, of McGill University. After an introductory reference to the recent outbreak on the island of Martinique, Dr. Adams gave an account of the general geological structure and petrographical character of the series of ancient volcanic hills which rise from the Paleozoic plain to the east of Montreal. These are eight in number and are arranged along two parallel and almost straight lines, evidently ancient lines of weakness. Those situated on the most northerly of these lines, commencing from Mount Royal on the west and going east, are Mount Royal, Montarville, Belœil, Rougemont, Yamaska and Shefford. The distance from Mount Royal to Shefford Mountain is fifty miles. The mountains on the southern line are two in number—Brome Mountain and Mount Johnson. Of these hills Mount Royal (Mons Regius), at the foot of which the city of Montreal is situated, is the best known and may be taken as the type of the series. Dr. Adams proposes for the group

the name of the *Monteregian Hills.* These hills form a most remarkable petrographical province, consisting of a dual series of alkali-rich rocks, represented on one hand by the essexitetheralite series, and on the other by the pulaskite and nepheline-syenite series. There are also a great number of dyke rocks of consanguineous types, bostonites, tinguaites, monchiquites, fonchites, camptonites, alnoites, etc. The hills are erosion remnants of volcanoes or laccolites, dating back probably to Neo-Paleozoic times. Dresser, who has recently studied Shefford and Brome, considers them to be partially uncovered laccolites. About Mount Royal, on the other hand, a few remnants of the ancient tufa pile remain, showing that the molten material at this point found a passage to the surface.

A detailed description of Mount Johnson was given. This very interesting occurrence is 875 feet high and nearly circular in cross section, being a little over half a mile in average diameter at the base. It is a typical neck or pipe, consisting of theralite in the center, which passes gradually over into pulaskite on going outward to the periphery. It is situated about seven miles from the town of St. Johns, P. Q.

Dr. G. F. Matthew discussed some geological questions arising out of his studies of the Cambrian faunas of eastern Canada, especially the initial faunas of this system, to the examination of which he has devoted himself with great industry for many years.

Six genera (and subgenera) of brachiopods are found at the very base of the system; and it is seen that there is a gradual, though no very marked, increase in size of these forms when traced through the basal Cambrian faunas. The genera (and subgenera) found were—of Atremata—*Leptobolus, Obolus, Lingulepis* and *Lingulella* —of Neotremata, *Acrothyra* and *Acrotreta.* The first of these two was the only genus that exhibited no increase in size as time went on, and it was found only in the basal Cambrian (below the Paradoxides zone).

The increase of bulk of the individuals of these old genera during this Geological Age is in accordance with the development in this respect of higher forms of life, but less noticeable in degree.

Another subject taken up by Dr. Matthew was the development of the Canadian Oboli, as shown in impressions of the muscle scars, of the vascular trunks, and by the surface ornamentation of the shells.

It was stated that in the first determination of these shells we must often depend on the form, as this is the most obvious, and sometimes the only, available character.

But further knowledge of the nature of the species, as shown by the internal markings, etc., has proved that there are several independent lines of development of the Oboloid shells, and that the typical *Obolus* (*O. Apollonis*) is nearer in structure to the typical *Lingulella* (*L. Davisii*) than to these earlier species, which outwardly, as regards the form, are indistinguishable from *Obolus.*

Of these shells one type belongs to the Lower Etcheminian fauna, one to the Upper Etcheminian fauna, two to the Protolemus fauna (all these are below Paradoxides), one to the Peltura fauna, and one to that of *Dictyonema* (*D. flabelliformis*).

Another subject discussed in these notes was the evidence of the direction of the migration which brought these early faunas to the Atlantic region of Canada. It was shown that during the time when the Upper Etcheminian fauna prevailed in Atlantic Canada, there was a steady current setting along the then existing shores to the northeast. This is shown by the orientation of the valves of the inarticulate brachiopoda, the apices of the valves being directed to the southwest. Hence it is inferred that the migration of the fauna was

from that direction. This is the reverse of the conditions shown by R. Rudemann to have prevailed in northern New York during the time of the Utica state; the direction of the current there and then being shown by the attitude of colonies of graptolites, which are turned in a southwest direction.

Papers on local geology of Ontario and New Brunswick were presented by Professor H. S. Coleman, of Toronto University, and by Professor L. W. Bailey, of the University of New Brunswick.

An afternoon was spent by the geologists with Professor Coleman in examining the interglacial deposits at Scarborough Heights on the northern shore of Lake Ontario, near Toronto.

The papers by Professor D. P. Penhallow, of McGill University, on Cretaceous and Tertiary plants, possessed special interest from the fact that they represented a continuation of the paleobotanical work carried on for so many years by the late Sir William Dawson. Among the material collected by the latter were many plants which, at the time of his death, had not been studied, or if so, but very casually, and Professor Penhallow has since that time devoted special attention to their critical examination. Plants from three localities form the subject of the present papers—Cretaceous plants from Vancouver and Queen Charlotte Islands, Tertiary plants from the Red Deer River, N. W. T., and also from the Horse-fly River, B. C. In each case the plants confirm previous testimony as to the age of the formation. From the Lower Cretaceous of Skidegate Inlet, Queen Charlotte Islands, there were obtained fragments of a fern which permitted the almost complete restoration of an *Osmunda* closely allied in most respects to the type of *O. Claytoniana*, though probably about seven times as large. In a few respects the internal structure showed it to approach the type of *Todea*, so that it may probably be taken as representing an intermediate form. *Ginkgo pusilla* and *Sequoia Langsdorfi*, previously known only through foliage and fruit, have now been recognized through the structure of the stem. In the collection from the Red Deer River, two new forms appear, and are unquestionably to be referred to the existing genera *Clintonia* and *Maianthemum*, as the foliage is identical in all essential respects. In the Miocene of the Horse-fly River, there was found the wood of a *Pseudotsuga*, which appears to be the first material of the kind recorded. The remainder of the material embraces well-known species of the Cretaceous and Tertiary formations.

Dr. Wm. Saunders, Director of the Central Experimental Farm, Ottawa, gave a striking illustration of the progress that is being made in introducing fruit plants into the Northwest. A hardy Siberian apple, which bears a fruit little larger than an Ontario haw, had been crossed with the Ontario apple. The result was the production of a fruit about an inch in diameter. About four hundred of these had been crossed, and last year they had thirty trees, and this year will have about seventy, bearing fruit. They retain the hardiness of the Siberian apple, but the more they are crossed the nearer the product comes to the Ontario fruit. Results of experiments in crossing English and American currants and gooseberries, plums and cherries with hardier varieties of these plants have not in all cases been successful, but enough has been accomplished to show that hardy varieties of Ontario fruits may be produced in the Canadian Northwest, which in addition to becoming the greatest wheat-producing region in the world, will also be known for its fruit products.

A paper on the botany of northern New Brunswick was read by Dr. G. U. Hay, in which was noted the large number of bor-

cal species found on the Restigouche River in close proximity to those of a more southern or New England type found along that river and on the upper St. John.

Dr. A. H. MacKay, Superintendent of Education for Nova Scotia, gave the results of a series of phenological observations carried on by the teachers and pupils of the schools in that province, one important object of which is the encouragement and stimulus given to 'nature study.'

The results of a series of interesting experiments, noting the behavior of blind animals, were given by Professor Wesley Mills, of McGill University; and Professor B. J. Harrington, of the same University, read an appreciative sketch of the life and work of the late Dr. Geo. M. Dawson.

The officers of the Royal Society for the current year are:

President, Sir James Grant, Ottawa; *Vice-President*, Lt.-Col. G. T. Dennison, Toronto; *Secretary*, Sir John Bourinot, Ottawa; *Treasurer*, Dr. Jas. Fletcher, Ottawa.

An excursion to Niagara Falls, of which about thirty members of the Society—chiefly scientists—availed themselves, was given by the citizens of Toronto. The party visited the works of the Canadian Power Company, whose guests they were for a day; and also were allowed to inspect the plant of the Niagara Falls Power Company on the American side, a favor which was greatly appreciated. G. U. HAY.

ST. JOHN, N. B.

SECTION OF THE MATHEMATICAL, PHYSICAL AND CHEMICAL SCIENCES.

BY special invitation the annual meeting of the Royal Society of Canada was held at Toronto, in the buildings of the University, on May 26–29. The sessions were largely attended, and the cool weather contributed to the success of the excursion to Niagara Falls (where the members were guests of the Canadian Niagara Power Co.) and of the trip along the lake shore to examine the interglacial deposits east of Scarborough.

The third Section (Mathematical, Physical and Chemical Sciences) met in the large physical lecture room, the President, Professor R. F. Ruttan, M.D., C.M., in the chair. 'Dalton and the Theory of Atoms' formed the subject of the President's address, and the reading of papers was diversified by a debate on the 'Existence of Particles Smaller than Atoms.' Professor Rutherford gave an account of the growth of the electron theory, and showed how the masses and velocities assigned to the hypothetical 'carriers' had been arrived at. Dr. J. C. McLennan exhibited a number of experiments illustrative of the facts on which the theory is based. Professor Lash Miller discussed the advantages and disadvantages of corpuscular theories in general, showing that they were impossible to prove and nearly as impossible to disprove, and Professor Cox spoke of the recent extension of the theory to cosmical phenomena. Professors Goodwin, Baker, Walker and Ruttan also took part in an animated discussion.

At the close of the sessions, Dr. J. C. Glashan, of Ottawa, and Professor H. T. Barnes, of Montreal, were elected members of the Section, and Professor M. Berthelot, of Paris, a corresponding member of the Society.

The following papers were read before Section 3:

MATHEMATICS.

On the Correlation of the Curve of the Second Order and the Sheaf of Rays of the Second Order in Geometry of Position: Professor A. BAKER.

Beginning with the curve of the second order, which may be considered to be defined by five points, tangents are constructed at these five points; and viewing

the tangents as the basis of a sheaf of rays of the second order, the original five points are shown to be points of contact. Reverting to the original five points, construction for a sixth point is made, and the tangent at that sixth point is obtained; this tangent is shown to belong to the sheaf of rays of the second order furnished by the five original tangents. It was also shown that the curve is uniquely determined whatever two points be selected as radiant points; and an analogous proposition was established with regard to the sheaf of rays.

On the Matrix Analysis of Quantics and Their Concomitants: Dr. J. C. GLASHAN.

A development of the consequences of applying to the operand as well as to the operator the notation of matrices.

Forms for the Abelian Integrals of the Three Kinds: Dr. J. C. FIELDS.

A Theorem Regarding Determinants with Polynomial Elements: Professor W. H. METZLER.

Generalization of a theorem of Muir's (*Messenger of Math.*, No. 153, 1884) omitting the restriction that the number of terms in each element of the determinant must be greater than the number of constituents in a row.

PHYSICS.

On the Use of the Wheatstone Stereoscope in Photographic Surveying: Capt. E. DEVILLE.

Description of an instrument proposed for drawing a topographical plan by mechanical means from a pair of stereoscopic photographs.

The Neutral Axis of Beams Under Transverse Loads: Professor H. T. BOVEY.

Experiments with a new Extensometer. The assumptions of the text-books are verified for a cast-steel beam of square cross section, but not for a T-beam.

Soli-Lunar Time: Mr. G. W. MCCREADY.

The average date of the first full moon in every decade for 4,000 years.

The Potential Difference Required to Produce Discharge in Air and Other Gases: Mr. W. R. CARR.

Experiments carried out under the direction of Dr. J. C. McLennan, with air, hydrogen, carbon dioxide, acetylene, hydrogen sulphide, nitrous oxide, sulphur dioxide and oxygen. The law governing electric discharges between parallel plates, in a uniform field, in any gas, for pressures at and below the critical pressures, is that which Paschen found to hold with spherical electrodes for high pressures, viz., that with a given spark potential, the pressures at which discharge occurs is inversely proportional to the distance between the electrodes.

The values of the spark potentials are not influenced by the material or size of the electrodes; and the minimum spark potential is independent of the pressure and of the distance between the electrodes, always provided that the discharge is compelled to pass in a uniform field.

Penetrating Rays from Radium: Professor E. RUTHERFORD.

Experiments showing the passage of the rays through from eight to ten inches of iron. The ionization produced by the rays after emerging from the iron shows that they must be regarded as consisting of negatively charged particles. Photographic methods are being applied to determine the magnetic deflection of the rays.

Radio-active Emanations from Thorium and Radium: Professor E. RUTHERFORD.

Résumé of a number of recent experiments by the author.

Excited Radio-activity from the Atmosphere: Mr. S. J. ALLAN.

The amount of the radio-activity is independent of the material of the negatively electrified wire. After exposure, the intensity of the radiation fell to one half in fifty minutes; while that excited by thorium fell to one half in eleven hours.

Radio-activity Induced in Salts by Cathode Rays and by the Discharge Rays from an Electric Spark: Mr. W. R. CARR.

Experiments carried out under the direction of Dr. J. C. McLennan. Radio-activity is excited in certain salts by Röntgen rays, as well as by cathode rays, and by the discharge rays from an electric spark.

Radio-activity Induced in Substances Exposed to the Action of Atmospheric Air: Mr. R. M. STEWART.

Experiments carried out under the direction of Dr. J. C. McLennan. The rate of loss of induced radio-activity depends on the potential at which the wire was exposed, rather than on the time of exposure.

On the Absolute Value of the Mechanical Equivalent of Heat: Professor H. T. BARNES.

The heat required to raise the temperature of one gram of water from 15.5° to 16.5° C. is equal to 4.1832×10^7 ergs. In gravitation units this becomes 426.60 kilogrammeters, or 777.58 foot-pounds.

On the Density of Ice: Professor H. T. BARNES and Mr. H. L. COOKE.

Historical résumé and criticism. New experiments. Probable cause of variation in density. Bibliography.

The Variation in the Density of Ice: Mr. H. L. COOKE.

The variation is ascribed to mechanical strains due to unequal expansion and contraction.

The Fall of Potential Method as Applied to the Measurement of the Resistance of an Electrolyte in Motion: Professor H. T. BARNES and Mr. J. G. W. JOHNSON.

Measurements of the conductivity of solutions of magnesium chloride. During the measurements the solution flowed slowly through the cell; the velocity of flow did not affect the results.

CHEMISTRY.

A Modification of Victor Meyer's Vapor Density Apparatus: Professor B. J. HARRINGTON.

The long stem is bent into a series of loops, and a second opening is provided for introducing the substance into the bulb. The apparatus is compact and convenient.

On the Determination of Moisture in Honey: Mr. F. T. SHUTT.

The honey is dried in a current of air at a constant temperature below 100° C., and the loss determined.

An Improved Method of Producing Concentrated Manure from Human Refuse: Mr. T. MACFARLANE.

Description of an odorless moss-closet. When properly used, the quantity of absorbent is not more than one twentieth of the resulting manure.

Experimental Investigation of the Conditions Determining the Oxidation of Ferrous Chloride: Mr. A. McGILL.

Ferrous chloride can be decomposed by oxygen in such a way as to yield uniformly from 75 to 85 per cent. of its chlorine in available form, and from 10 to 20 per cent. as hydrochloric acid.

Analysis of Anthraxolite from Hudson's Bay: Professor W. H. ELLIS.

A sample brought by Mr. G. R. Mickle from Long Island, Hudson's Bay, contained 0.54 per cent. ash. The dry ash-free mineral gave: carbon, 96.54; hydrogen, 1.33.

Abnormal Results in the Hydrolysis of Amygdaline: Professor J. W. WALKER and Mr. W. S. HUTCHINSON.

Boiled with dilute acids amygdaline is resolved into glucose, hydrocyanic acid and benzaldehyde. Heated with concentrated hydrochloric acid it yields a humus substance and dextro-mandelic acid. Boiled with dilute alkalies it yields ammonia and amygdalinic acid, which on hydrolysis with dilute hydrochloric acid gives inactive mandelic acid.

Oudemann's Law, and the Influence of Dilution on the Molecular Rotation of Mandelic Acid and its Salts: Professor J. W. WALKER.

Strong indications were found that the law was not confirmed in very dilute solutions, where it ought to hold most rigidly.

Specific Heats of Organic Liquids, and Their Heats of Solution in Organic Solvents: Professor J. W. WALKER and Dr. J. HENDERSON.

An electric method is employed for determining the specific heat; a close connection is indicated between the degree of association of a liquid and its heat of solution in an unassociated solvent.

The Specific Heat of Water of Crystallization: Mr. N. N. EVANS.

The solid, finely ground, is suspended in a suitable liquid in the calorimeter, and a measured quantity of heat is introduced electrically. A range of four degrees is sufficient for accurate results.

Researches in Physical Chemistry Carried Out in the University of Toronto During the Past Year. Communicated by Professor W. LASH MILLER.

Under this head the following eight papers were introduced.

Application of Polarimetry to the Determination of Tartaric Acid in Commercial Products: Professor E. KENRICK and Dr. F. B. KENRICK.

The method is based on the addition of ammonium molybdate to the material to be analyzed; it is applicable in the presence of alum, iron, sugar, etc.

The Sulphates of Bismuth: Dr. F. B. ALLAN.

An application of the phase rule. The following salts were identified: $Bi_2O_3.4SO_3$, $Bi_2O_3.2SO_3.2\frac{1}{2}H_2O$, $Bi_2O_3.SO_3$. (*Am. Chem. Jour.*, 27, 284.)

The Influence of Iron Salts on the Rate of Reaction Between Chromic Acid and Iodides: Miss C. C. BENSON.

The rate of liberation of iodine as a function of the concentrations of the reacting substances; and the rate of oxidation of ferrous salt by chromic acid in presence and absence of iodide.

The Reaction Between Stannous Chloride and Potash: Mr. C. M. CARSON.

The results are in conflict with those of Ditte.

The Rate of Oxidation of Iron Salts by Oxygen: Mr. J. W. MCBAIN.

Experiments carried out under the direction of Dr. F. B. Kenrick. (*Jour. Phys. Chem.*, V., 623.)

The Rate of Reaction in Solutions Containing Potassium Chlorate, Potassium Iodide, and Hydrochloric Acid: Mr. W. C. BRAY.

Experiments showing that two reactions of the fourth order occur simultaneously. Schlundt's results are recalculated.

The Rate of the Reaction Between Arsenious Acid and Iodine in Acid Solution; the Rate of the Reverse Reaction; and the Equilibrium Between Them: Mr. J. R. ROEBUCK.

The 'Thiosulphate Method' of Measuring the Rate of Oxidation of Iodides: Mr. J. M. BELL.

The method was introduced by Harcourt, using sodium peroxide as oxidizing agent; it is not applicable when chloric acid, chromic acid, or ferric salts are employed. Schükarew's assumptions (*Zeit. Phys. Chem.*, XXXVIII., 357) are not justifiable.

W. LASH MILLER,
Secretary pro tem.

PROBLEMS IN THE CHEMISTRY AND TOXICOLOGY OF PLANT SUBSTANCES.*

THE organic chemistry of to-day is the chemistry of the approximately 50,000 carbon compounds, enumerated in the recent edition of Beilstein's 'Handbuch der Organischen Chemie.' Most of these compounds are the fruit of research in purely synthetic chemistry, enormously stimulated, as it has been of late, by the growth of new, far-reaching conceptions in physical chemistry, and, especially, by the substantial rewards of the chemical industries which have arisen as a result of these investigations; a considerable number of the compounds enumerated have, however, been isolated from plants. Some of this work of plant investigation has been adequately rewarded, but as a rule it has only awakened a greater esteem for the investigator. The larger returns of synthetic chemistry are still enticing most of our best organic chemists into its fold, but its phenomenal success in producing substances such as urea, sugar and several plant alkaloids and glucosides hitherto known only as the products or educts of life, has stimulated inquiry not only into the chemical nature of cell life, but also into the chemistry of the dead principles that may be isolated from these cells. Mother Nature is, however, a very cunning and crafty chemist, with a keen understanding of all of the requirements of cell growth under astonishingly varied conditions of environment, and especially with an eye for the protection and perpetuation of her multitudinous progeny against the ravages of parasites, or of man and beast, she has built up a very great variety of compounds, the properties and methods of formation of many of which she still holds secret. Many of these compounds, especially those primarily designed for the protection of the plant, react physiologically on diverse forms of animal life, and are, therefore, recognized by the medical fraternity and by chemists as 'active principles.' All which produce disturbances of the normal functions of an animal when introduced into its economy are, according to Hermann's well-known text-book on pharmacology, called poisons.

It is a sad commentary on the present state of our knowledge of plant chemistry that all we know chemically about the active principles of many plants is that the plants themselves are poisonous. Chemistry might be excused for her lack of interest in examining such physiologically-inert bodies as cellulose and chlorophyll, but it would seem that the plant poisons should at once challenge attention simply on account of their great tendency to react chemically, as they do with some one or more of the essential constituents of the animal organism. The dreaded effects upon man of such plants as the 'deadly upas,' the 'deadly manchineel,' or the common 'poison ivy,' deter many chemists from handling them, and, as shown above, there is little inducement financially for one to enter into such investigations, but the chemist's lack of a knowledge of botany is more frequently the controlling factor in this neglect. Many of the most interesting problems of plant poisoning cannot be conceived either by the chemist or by the botanist alone, but one who is

* Address of the retiring president of the Chemical Society of Washington, April 10, 1902.

constantly looking at these problems from both points of view could not well be thrown into intimate touch with the subject long before many interesting problems would be presented to him for solution. When once conceived these problems are readily susceptible of treatment, either by the chemist or the physiologist alone, or by one or both of them in conjunction with the botanist, the biologist or the pharmacologist. It was with the object of interesting you, as chemists, in this line of work that I was induced to select it as the subject of my discourse on this occasion. No more interesting and self-sufficient life-work could possibly be suggested to a young student starting on his college career than the investigation of plant poisons. As fascinating as a game of chess, the work calls forth, for its most successful treatment, the widest activities of mind and the most skillful handling of finely adjusted instruments. Art and literature lend a peculiar charm to the work, while the warm plaudits of men await him who solves any of the important chemical problems of immunity. This inviting field comes, I maintain, as properly within the scope of plant chemistry as within that of medicine, for disease is simply a disturbance of the natural functions of the animal economy, caused by poisons, many of which are excreted within the affected animal by such low plant organisms as bacteria and perhaps molds. Indeed it has been shown that all of the lesions supposed to be caused by certain living bacteria can be produced by the administration of sterilized filtrates, obtained by passing extracts made from the bacteria through a Pasteur filter.

Plant poisons divide themselves most naturally and most comprehensively according to their plant origin; all attempts at a chemical classification have been incomplete because of our ignorance of the composition and structure of many of the compounds, while the physiological classification is unsatisfactory on account of our ignorance of the chemical composition of the compounds and of their exact mode of action on animal life. Let us inquire into the nature of the parallelism which exists in the grouping of plant poisons, and the grouping of the plants which contain them!

Plants are commonly divided into species, genera and families, and these are grouped into two series—the flowering and the non-flowering plants—the latter being the more simple morphologically. Each of these in turn is grouped into smaller classes. Proceeding from the more simple to the more complex, we have in the non-flowering plants such groups as the bacteria, the diatoms, the molds, the fleshy fungi, the mosses and the ferns, while in the flowering plants we have the monocotyledons with parallel-veined leaves and the dicotyledons with net-veined leaves. This classification is, in general, based on the general morphology of the plant, but in the lower orders, especially in the bacteria, the chemical composition or at least the chemical and physiological reactions which the plant is able to induce are taken into consideration in the differentiation of the species. In many of the subdivisions in the higher groups, however, there is often an apparent chemical basis for classification. It seems just as reasonable to suppose, as van Rijn has shown in his book entitled 'Die Glykoside,' that there should be genetic relationships between the chemical substances represented in any one group of plants, as that there should be morphological relationships. Both results are brought about entirely by the energy of the living cell, a process which is undoubtedly largely chemical in its character, and would seem almost as necessary for a plant to gradually evolve new and therefore closely related chemicals for slight changes in environment, as that it should evolve new

and closely related forms for the same purpose. The relationship between the chemical constituents of certain groups of plants cannot, of course, be so apparent as is the morphological relationship, simply because it cannot be determined by inspection alone, as the latter can. If, therefore, our knowledge of plant constituents were sufficiently complete we could perhaps write monographs classifying the different species of plants according to their chemical constituents, as well as we now write monographs based solely on morphology. The same alkaloid is often found exclusively in certain families of plants, but the same family, and even the same species, often contains one or more alkaloids which differ from each other by a few atoms of hydrogen or a few simple organic radicals, or they may differ only in being isomers or polymers. In many of these cases one compound can often be transformed into another by a few simple reactions.

Of the two great classes of plants—the non-flowering and the flowering—the former contain very few active principles, and those which do exist are far more simple than those which are found in the flowering plants. In the bacteria, to be sure, we have highly developed poisonous compounds, the toxalbumins, but aside from these there are few active principles in them. The simpler group of poisonous acids is here more abundant; there are few glucosides and still fewer alkaloids. The most prominent of the latter are ergotine from ergot, and muscarine from the fly fungus (*Amanita muscaria*). There has been an immense amount of study done on the former but its chemical composition is still in a most unsatisfactory condition. Trimethylamine, one of the simplest of the so-called alkaloids of the aliphatic series, is also present in ergot at certain stages of its growth. According to the definition of alkaloids now commonly accepted, however, neither trimethylamine nor muscarine is an alkaloid, this class being restricted to the benzol or aromatic series of compounds. Proceeding still higher in our grouping of plants we find that there are but two conspicuous alkaloids, toxine and ephedrine, in the lowest group of flowering plants, and that, in the many families of the next higher group, the monocotyledons, there is but one family, the Melanthaceæ, which contains more than one or two important alkaloids. In the highest group, however, there is a long list of alkaloids, arranged often in groups, characteristic of the family to which the plants belong. The atropine-like alkaloids of the Solanaceæ; the strychnine-like alkaloids of the Loganiaceæ; the morphine-like alkaloids of the Papaveraceæ; and the quinine-like alkaloids of the Rubiaceæ are the best well-known groups. There is a similar distribution of the glucosides throughout the plant kingdom, but these compounds, being simpler than the alkaloids, are found lower down in the plant scale. It is interesting to note, however, that throughout the whole list of the tremendously abundant family of grasses, one of the lowest families of flowering plants, there are but two glucosides, neither of which is at all well known. One of these is loliin, from the poison darnel, *Lolium temulentum,* while the other, setarian, was isolated from millet so recently as in 1899 by Professor E. F. Ladd, chemist of the Agricultural Experiment Station at Fargo, North Dakota. The grouping of all plant constituents in accordance with their plant classification offers a tempting field of work, but this cannot well be undertaken to advantage until the identity and nature of a great many more plant substances have been determined.

Sohn's 'Dictionary of the Active Principles of Plants' enumerates about 600 substances, all of which are included under

the three commonly recognized classes of these bodies, viz., the glucosides, the amaroids or so-called bitter principles, and the alkaloids. These three classes do not, however, include all of the groups of toxic substances which are represented in plants. In addition there are mineral substances, which under certain conditions may be taken up by plants, acids, oils, enzymes and their closely related congeners—the toxalbumins.

Mineral substances very rarely cause poisoning on account of their occurrence in plants, but it has been shown that the presence of lead in a certain grass has led to distinct symptoms of lead poisoning in cows that ate it. An exceedingly important problem suggests itself in this connection and that is the possibility of poisoning from the gradually increasing use of insecticides on fruit trees and on vegetables. It has already been pointed out that plants which have been manured with superphosphates, which frequently contain arsenic, may absorb arsenic into their tissues to such an extent that arsenic poisoning may result from eating them.

The great toxicity of prussic acid is well known. It occurs free in certain plants and in the form of a glucoside in several others, especially in those belonging to the rose and apple families. Oxalic acid is also present in the form of an acid oxalate in many plants. It is extremely poisonous. Crotonoleic acid, from *Croton tiglium*, is still more poisonous, the fatal dose being represented by only .38 of a milligram per kilogram of body weight. Poisonous acids are not so generally looked for in plants as they should be, and it is quite possible that the active principles of some plants, the chemical nature of which is still unknown, are acids. The effect of the common locoweed of the Western States, *Astragalus mollissimus*, has been attributed to loco acid.

The medicinal and therapeutic effects of the vegetable oils are tolerably well known, but it is not commonly recognized that some are poisonous. Among the most powerful of these are the oils of chamomile, cloves, cinnamon, sassafras, savine, rue, hedeoma, and tansy. Many of these are commonly used as flavor and to preserve food, but it is certain that their excessive use might result in serious gastric disorders if not in death. All are useful on account of their being antiseptic, a property which was commonly recognized centuries ago by the Egyptians in embalming bodies. Nutmegs contain a volatile oil which is toxic; two of the nuts proved fatal to a young girl who ate them. The extreme toxicity of toxicodendrol, the non-volatile oil of the common poison ivy, *Rhus radicans,* and poison sumach, *Rhus venenata,* has recently been shown by Dr. Franz Pfaff, of the Harvard Medical School, who proved that the hundredth part of a milligram easily caused a severe dermatitis on many persons, while as little as the thousandth part of a milligram caused severe itching of the skin and half a dozen vesicles on some persons, and localized œdema on others that were more sensitive to its effects.

The glucosides are well known. One of the most poisonous representatives of the group is the active principle antiarin, from the East Indian tree so well known to legendary history as 'the deadly upas.' Its juice has been used in times of war by savage tribes to envenom their arrows. It takes but one to two milligrams of this glucoside to kill a moderate-sized dog in nine minutes. Frogs are killed with a hundredth of a milligram in twenty-four hours. The results of a most interesting investigation on the poisonous constituent of a leguminous plant of Egypt, known botanically as *Lotus arabicus,* have been recently published by two English investigators, Messrs. Dunstan and Henry. Its

seeds when ripe are commonly used as fodder, but the growing plant is quite poisonous to horses, sheep and goats. It was noted that when the dry leaves were crushed and moistened with water they gave off an odor of hydrocyanic acid. An investigation revealed the presence of a glucoside, lotusin, which was hitherto unknown. Under the influence of an enzyme, also present in the plant, the lotusin was transformed into prussic acid, sugar and a new coloring matter called lotoflavine. It will thus be seen that this glucoside is very similar in its properties to amygdalin and also to linamarin from common flax. These glucosides may cause poisoning when taken into the stomach but are innocuous when administered hypodermically, for in the latter case they are excreted unchanged, while in the former they are apt to be decomposed by the acids and enzymes of the stomach.

The class of amaroids has not been well investigated chemically, but we know several compounds belonging to the group which are extremely toxic. Cicutoxin is the poisonous constituent of the common water hemlock, *Cicuta maculata,* a plant which probably causes more fatal cases of poisoning in the United States than any other plant. Digitoxin, one of the poisonous constituents of the foxglove, *Digitalis purpurea,* is poisonous to cats in a dose of 0.4 of a milligram per kilogram of body weight, while andromedotoxin, the poisonous constituent of many Ericaceous plants such as the common laurel, *Kalmia latifolia,* and the rhododendrons, is still more toxic, being fatal to frogs and to birds in a dose of 0.1 of a milligram per kilogram when injected subcutaneously. But, as we shall see, it is much less fatal when fed to birds. It is much more fatal to frogs than is atropine or strychnine.

The alkaloids are so well known that they do not need much discussion here. Aconitine is one of the most poisonous, being fatal to birds in the small dose of 0.07 of a milligram per kilogram when injected hypodermically.

The enzymes are not very well known, and in most cases they are not toxic. Some of them are, however, capable of causing disorders when injected under the skin. Very closely related to these are the toxalbumins which embrace the most deadly of all of the poisons, as may be recognized from the fact that they are the poisonous constituents of the venom of snakes and spiders, of many pathogenic bacteria, and of the most poisonous fungi, such as *Amanita phalloides.* We shall have more to say about these substances later.

Nearly all of the active principles which have been isolated from plants have also been studied toxicologically, and have been classified in different ways, but chiefly with regard to the character of their effect and the organ most seriously poisoned. We thus have those which cause marked anatomical changes of tissues, those that principally affect the blood and those that do not cause any marked anatomical lesions. The fatal dose, also, has in many cases been established, so that we can often tell how much of a given substance will kill a given animal in a given time. In this determination it is absolutely necessary, of course, that the animal tested be a healthy one, otherwise a fatal lesion may be produced by the poison simply on account of the previous weakening of the affected tissue by the disease. The time and dose limitations of poisoning are not essential in our accepted definition of a poison, for it considers only derangements of function. If these are produced even by commonly edible substances, such as sodium chloride or sugar, we are obliged to say that under the special conditions of the case in hand these substances are poisonous. Sugar is thus poisonous to a diabetic patient, while

pure salt when fed regularly even in normal quantities would undoubtedly prove fatal if all other salts were withheld from the food for a considerable time; half teacupful doses of the saturated solution are said to be sometimes taken by the Chinese to commit suicide. This elimination of the time and dose elements makes it very difficult, sometimes, to distinguish poisonous substances from foods, but it is eminently satisfactory because it calls for subsequent explanation showing in what way and to what extent a substance is toxic. It calls more forcibly to mind, also, the danger in the continued use of drugs and of such narcotics as tobacco and hasheesh, and also to the flagrant and outrageous use of antiseptics in such foods as milk and bread which are consumed daily, sometimes in large quantities. Who can say how much material damage is done to the progress of civilization by this criminal practice? Until proven to the contrary, it ought to be taken for granted that any substance which has antiseptic or germicidal value is also capable of exerting these properties in a deleterious way in the human body, especially when the substance is ingested frequently for a long period of time. The Spanish people are said to be a race of dyspeptics because of their inordinate use of condiments; let us pray that the American people will never become degenerate on account of the use of the antiseptically preserved food which is too often sold in our markets.

There are 16,673 leaf-bearing plants included in Heller's 'Catalogue of North American Plants,' and of these there are nearly 500 which, in one way or another, have been accused of being poisonous. This does not, of course, mean that any one part or all of each of these plants would be fatal if eaten by man or by any one kind of an animal, but simply this, that some part or parts of each, at some period of the plant's growth, contain an active principle which is capable of causing death or some serious derangement of function in one or more forms of animal life when administered in a certain way, not necessarily by way of the mouth. Snake venom is none the less poisonous because it can be swallowed with impunity in considerably more than what would be a fatal dose if injected into the skin in the natural way through the serpent's fangs; neither is the death cup, *Amanita phalloides,* to be considered non-poisonous because it has been eaten after the poison was extracted by chemical methods. Other plants may be eaten with other things which will either enhance their poisonous effect, as in the case of amygdalin when an amygdalin-splitting ferment is also consumed, or counteract it, as might be the case when other medicinal plants are eaten; others again may be considered non-poisonous because the active constituent may be removed or destroyed from the plant by boiling or by drying; and finally others may be declared innocent because the poison is not present in the part consumed, or is present only at certain brief stages of growth; the amount present might also have been increased or diminished according to the conditions of growth or cultivation of the plant, as is most commonly the case in those which are cultivated for their medical value.

We cannot take time to even mention all of the unsolved problems which have arisen in connection with all of these suspected plants, but there are several interesting questions in connection with the variable amount of poison present in a plant, its variable location in the plant, and especially the variable effect upon animals, that should receive special attention.

Few poisonous plants are of sufficient commercial importance to have been investigated chemically with anything like the detail necessary in order for one to draw

definite conclusions in regard to the development of their poisons, or of their location in the plant, but all druggists and physicians are aware that the chemical compound by virtue of which a drug is of therapeutic value is almost invariably more abundant in one part of a plant than in another. The same is true of all plant compounds. The variability of cultivated drugs in their contents of active principles was alluded to above. A more satisfactory example of how artificial environment can affect the chemical constituents of plants may be found in a Bulletin recently published by Dr. H. W. Wiley, Chief of the Bureau of Chemistry of the Department of Agriculture, and entitled 'The Influence of Environment upon the Composition of the Sugar Beet.' In this bulletin it is shown that the factors which determine the maximum yield of sugar are as follows: high latitude, free use of fertilizers, and an even distribution of a rainfall of from three to four inches during the months of May, June, July and August, and a reduction of rainfall for September and October.

Natural environment affects some poisonous plants in a similar way, but in this case the more southerly plants are apt to have a greater development of the active constituents than those further north. This is particularly noticeable in the Indian hemp, *Cannabis sativa.* The plants of the Southwest contain a larger quantity of the active principles than the more northerly ones do. A striking example of the possible diurnal variation of the amount of poison in the leaves of plants is shown in a very instructive investigation by Dr. J. P. Lotsy of the cinchona plant. The author showed that the quantity of alkaloids varied greatly in the leaf as taken by day or night and on sunshiny or cloudy days, being most abundant in the first instance in each case. He showed also that these alkaloids are formed in the leaves during the day and are almost wholly deposited in the branches or bark at night. If gathered in the early morning therefore cinchona leaves would be practically inert, while if gathered in the evening, especially on a sunshiny day, they would be in their most active condition. The foliage is, in general, the part of a plant which causes most cases of stock-poisoning. The period of leaf maturity is regarded by some cultivators of medical plants as being the time at which its chlorophyll content is most highly developed, or when the leaves are most intensely green. This is generally soon after the flowering time in the case of herbaceous plants, but with some, such as the aconite, the purple larkspur and the poison camas of Montana, and many bulbiferous plants closely related to the last, it is earlier, the leaves of some of these having commonly dried up before the plants have flowered. In such cases the leaves would naturally be most active physiologically if eaten before the plants blossom, and might be practically inert at other times. Such is probably the case with the purple larkspur and death camas just referred to. The active principles are sometimes found most abundant in the most rapidly growing parts of the plant, as in the white sprouts of potatoes, and again they are to be found in parts which have been fully developed, as in the case of sapotoxin in the corn cockle, *Agrostemma githago.* It has recently been shown that in aconite seeds the central parts contain most of the aconite, while the seed coats are free from it. In the calabar bean the very poisonous alkaloid eserine is found in the cotyledons. In the seeds of the common jimson weed and black henbane the alkaloids are located chiefly in the layer beneath the epidermis; the epidermis itself and the seed covering of each are free from alkaloids. In jimson weed the quantity of alkaloids in un-

sprouted seeds was found to be fifteen times as great as in sprouted seeds, and in the seedlings of the jequirity bean, *Abrus precatorius,* it has been definitely shown that most of the toxalbumin is retained in the cotyledons. In growing colchicum the percentage of alkaloid is high in the growing tips and comparatively low in the lower part of the bulb. The first year's crop of leaves of foxglove and of henbane is inferior to that of the second on account of the smaller quantity of active principle. The variation in strength of the powerfully poisonous drug known as strophanthin is so well known to physicians that its medical use is being abandoned. Many such instances might be cited, but these show the importance of knowing the entire history of a plant in testing its character as poisonous or non-poisonous.

There are several molds and smuts which often infest corn and fodder. We know that some of these, when eaten or inhaled, sometimes cause death in a mechanical way by clogging up the system by their growth within the body, but there is much reason to believe that some of them contain poisons which are either consumed with the mold or are generated *pari passu* with the growth of the mold in the body. Probably some of these compounds like the sulphocyanic acid of *Aspergillus niger*—a weak poison—are absorbed with difficulty, especially when taken into the stomach, and this may be the reason why the plants are often eaten with comparative impunity. But are there not conditions when a greater quantity of toxic substances may be present in them, or may there not be a condition of the system in which the poison is more easily absorbed? The large number of cases of stock-poisoning said to have been caused by molds and smuts demand an extended investigation.

Another problem which is essentially of the same nature is in connection with the large polymeric group of saponin-like glucosides. These substances are, as a rule, not very poisonous when taken into the stomach, but it is a noticeable fact that few of the many plants which contain them are eaten by animals. Some are, however, eaten both by the lower animals and by man, as is the case with the fruit of the Moreton Bay chestnut or bean tree, *Castanospermum australe,* of Australia. Some persons assert that this fruit is edible, others that it is merely indigestible, while still others are emphatic in regard to their deleterious effect upon man. Nearly all of the saponins are difficult to dialyze, so it is quite probable that when taken into the stomach they are ordinarily excreted before they can accumulate in sufficient quantity in the blood to cause symptoms of poisoning, but in other cases where poisoning has resulted it seems probable that some condition of the digestive tract, perhaps ulceration, has facilitated the absorption of the compound into the system, where it at once exerts the same powerful effect that it does when injected hypodermically.

Some animals are, for various reasons, entirely immune against the effect of certain poisons. This difference in susceptibility is, in general, correlated to the mental development of the animals compared. The brain and nerve poisons, such as morphine and atropine, are much less poisonous to animals than man. Dogs and horses can, in proportion to their weight, endure ten times as much morphine as man, while doves can stand 500 times and frogs even a thousand times as much. In herbivorous animals, especially in those which chew their cud, such as sheep and cattle, the digestive tract is much longer than in the case of omnivorous or carnivorous animals, consequently the food remains in the body for a much longer period. In case of herbivorous animals this period is usually several days, while in carnivo-

rous animals it is about twenty-four hours only. In the former case, therefore, the poison would have much more time to become absorbed into the blood than in the latter. This, according to Fröhner, probably explains why it is that the metallic poisons are much more fatal to herbivorous than to carnivorous animals.

The flesh of an immune animal to which a large dose of poison has been administered is apt to be poisonous to other animals that eat it if they themselves are not immune to its effects. For example, it is asserted that advantage is taken of this fact in our Southern States in feeding strychnine to chickens in order to poison the hawks that prey upon them. Cases of human poisoning may inadvertently occur by thus eating the poisonous principles of plants which are present in the honey, the milk or the meat derived from certain plants.

All grades of merit or flavor are attributed to the honey derived from plants, thus indicating that the chemical constituents which give characteristic odors and tastes to flowers are often transferred directly to the honey derived from them. Some of the undesirable constituents of nectar are probably eliminated by the bee in some little-known way, and other portions are perhaps selectively retained. Formic acid is a poisonous substance which is found as an apparently essential constituent in all honey, but as it is present only to the extent of about three grains per liter it does not produce toxic effects. Gelsemine, the poisonous constituent of the southern jessamine, *Gelsemium sempervirens*, is said to have been found in honey from Branchville, South Carolina, and andromedotoxin has lately been found in honey from *Rhododendron ponticum* of Europe. The most convincing proof that poisonous honey may be derived from rhododendrons and that its toxicity may be due to andromedotoxin has been furnished by Plugge and Thresh. The former has obtained the poison from the nectar of *Rhododendron ponticum;* the latter found it in 1887 in a sample of honey from Trebizond.

Cases of poisoning from milk are more apt to happen nowadays from the use of preservatives and from bacterial toxines rather than from any other causes, but cases arise from milk becoming sour while in metallic containers or from the plants eaten by an animal. The effect of garlic on milk is well known but it is not so well known that cabbage and turnips also give milk a bad taste. Chicory imparts a bitter flavor to milk and Dyer's weed, *Genista tinctoria,* is said to make the butter and even the cheese made from milk derived from it very unpleasant to the taste. Kobert states that children have been killed by the milk of goats that had eaten colchicum or the broom plant. In my 'Preliminary Catalogue of Plants Poisonous to Stock' mention was made of a severe case of poisoning which was due to drinking milk from a cow that had been feeding on mandrake, and investigations made by Dr. E. V. Wilcox and myself in Montana show that lambs are frequently killed by sucking milk from their mothers after these had eaten death camas, *Zygadenus venenosus.* It was a common impression throughout various districts in the South only a few years ago that the disease known as 'milk-sick' was due to milk from cows that had been eating poisonous plants. This problem has never been solved, although the disease is still reported occasionally. Other cases of such poisoning are comparatively rare, but two have recently been reported to the Department of Agriculture, one from Nebraska and another more important one from the Pecos Valley in New Mexico. The butter and cheese were also suspected in the latter case.

The interest in connection with poisonous honey is both theoretical and practical; that with poisonous game is, perhaps, only theoretical, since no cases have been called to public attention for many years and the records of past cases are few in number. To determine whether the flesh of a bird or animal that has eaten a poisonous plant is poisonous or not it is necessary to prove: first, that the birds or animals in question may eat the suspected plants with impunity to such an extent as to render their flesh poisonous; and secondly, that, perhaps under stress, they actually do so. This latter point can be solved only by the close study of actual cases. An attempt was made by the writer a few years ago to examine into the former question, especially in connection with some historic cases of poisoning, supposed to have been due to eating partridges which had fed on mountain laurel, *Kalmia latifolia*. It is true that partridges eat laurel leaves in winter, and that they may not be poisoned thereby. I have seen as much as 14 grams of the leaves taken from the crop of a single partridge, yet this bird was eaten without any ill effect arising therefrom. In this case, however, the leaves were still in large pieces, many of them being over a half inch square. The andromedotoxin was, therefore, not extracted, and, unless the bird's previous meal consisted of the same food, its flesh could not have contained much of the poison. Andromedotoxin was fed for several days in gradually increasing doses to a chicken, which, at the end of the fourth day, had received a very large dose without affecting it at all seriously. The chicken was then killed, cleared of entrails, boiled for a half hour and fed to a cat with the result that it was very badly, but not fatally, poisoned. Similar problems might be suggested in connection with the poisonous plants eaten by game animals, and especially in connection with the edibility of fish caught for food by the use of plants thrown into the water to stupefy and poison them. Some detective work, also, is desirable to determine to what extent poisonous plants are clandestinely added to whiskey and other alcoholic beverages to increase their intoxicating effect. It is reported that in some country districts throughout the South use is thus made of the leaves of mountain laurel and other andromedotoxin-containing plants.

The practices above mentioned suggest another subdivision of my paper, and that is the effects of the habitual use of narcotic plants. In the United States this use is confined mainly to tobacco smokers, but it is interesting to note that the use of Indian hemp is spreading throughout the Southwest, where it was most probably introduced from Mexico. The effect of this drug is well known from accounts published in the daily press and elsewhere. The common Mexican name of the plant in '*mariguana*,' but this name is also applied in some parts of Mexico to a native *Datura*, *D. meteloides*, much like our common jimson weed. Both of these plants and others, such as the tree tobacco, *Nicotina glauca*, are sometimes called locoweeds in Mexico. 'Loco' is a Spanish word which, in its original sense, means mad or crazy. Of late, however, it has been extensively applied, especially in northern Mexico and the United States, to certain plants which so affect the brain of animals that eat them as to cause chronic derangements of the power of thinking and of coordinating movement. It is, however, most popularly applied to several weeds—*Astragalus* and *Aragallus* spp.—of the bean family, which cause a peculiar kind of insanity in animals that eat them. It is not uncommonly asserted by Mexicans that sometimes a single dose of hemp will cause long-lasting insanity. Van Hasselt, a Dutch authority on poisonous plants, also asserts that a single dose of this drug may cause mania for months,

but the best pharmacologists are agreed that such might be the case only when the person affected is already badly diseased by the use of drugs or otherwise. There is reason for scepticism here, especially in regard to the crazing effect of single doses, but it is highly desirable that the subject be inquired into to find out how little of any one plant can cause insanity in a short time. With the true locoweeds of our Western prairies I am satisfied that at least several days' feeding is necessary to produce any bad effect. The Department of Agriculture is at present engaged in an investigation of the curious behavior of these weeds.

The question of disease-producing food presents many important problems closely related to those mentioned above. Aside from the study of locoism there are such problems as the relation of ergotism to the ergot of rye; of lathyrism to the seeds of the species of *Lathyrus* and *Vicia,* both commonly represented in our native flora; of the so-called 'bottom disease' of Missouri and the seeds of the rattlebox; of githagism to the seeds of the common corn cockle which is abundant in the wheat fields of the middle Northwest, and also to the spring cockle, *Vaccaria vaccaria,* which is also becoming common in the extreme Northwest, and finally the relation of dry food or of dry moldy foodstuffs to blind staggers or cerebro-spinal meningitis and the so-called cornstalk disease of the middle Western States.

The toxic theory of disease is by no means a new theory, for Albrecht von Haller advanced it about the middle of the eighteenth century in connection with the extracts of putrefying animals, but it has received proper prominence only lately in connection with the toxalbumins, the first of which to be described was 'echidnin' or 'viperin.' This was extracted in 1843 by by Prince Louis L. Bonaparte, from the venom of vipers. Crotalin, the poison of the rattlesnake, was described by Dr. S. Weir Mitchell, an American, in 1860. But it was not until after 1884, when two English chemists, Warden and Wadell, isolated abrin from the seeds of jequirity, *Abrus precatorius,* that these bodies were closely investigated in plants. Since 1884 ricin has been isolated from the castor-oil bean, crotin from a bean of the same family, phallin from the deathcup fungus, *Amanita phalloides;* and robin from the bark of the common locust. From many pathogenic bacteria and from some poisonous spiders similar compounds have been isolated. All resemble ordinary albumen in being coagulable by heat and all are remarkably poisonous, but death often ensues only after several days when the poison has been taken internally. After these substances once get into the blood there is no established method of offsetting their effects. There is, however, a most interesting method of preventing and perhaps offsetting their effect which is bound to come more and more into general use. I refer to the use of blood serum and to the various artificial ways of producing immunity or a high degree of tolerance.

Ehrlich, a German investigator, first showed in 1891 that animals can be made to endure very large doses of two plant toxalbumins, abrin and ricin, and, in 1897, Cornevin showed that by heating ricin to a temperature of 100° C. for two hours a substance is formed which, when injected two or three times under the skin of hogs, ruminants or chickens, will produce immunity against the effects of ricin for several months. The essential factor of success in combating these poisons within the body seems to be the development of an increased number of white blood corpuscles within the body. It has been experimentally proven that these corpuscles are not only capable of attacking the destroying bacteria, but also of destroying toxic substances present in the body, the chem-

ical reaction involved being probably an oxidation. These bodies contain an oxydase or oxidizing ferment, and it is known that such oxidizing bodies as permanganate of potash and chloride of lime easily oxidize most if not all of the toxalbumins and thus render them harmless. Any substance, therefore, which is capable of developing a larger number of white corpuscles in the body would serve as a kind of antitoxine against these poisons and it would not appear to be necessary that each particular toxine should have a separate antitoxine. Indeed, experiments show that antitoxines are not chemical antagonists to toxines, but act simply as stimulants to the body to manufacture its own antidote. Certain chemicals, such as sodium hypochlorite and nuclein, an albuminoid obtained from cæsine or from beer yeast, stimulate the production of these cells, and these substances may, therefore, be looked upon as antitoxines. Whether or not these substances will also stimulate the white corpuscles or the other oxidizing organs of the body so that they will offset the effect of plant poisons is a problem which is yet to be solved. It is not known how many poisons the leucocytes are able to destroy in the body, but if their action is really in the nature of an oxidation we may assume that all poisons which are harmless when oxidized, as plant poisons are apt to be, would be destroyed by them whenever they gained access to the blood, providing, of course, that the leucocytes were in sufficient abundance to do the work. We see then the great importance both from the poisonous-plant point of view and for general prophylactic effect against disease of building up an animal's system so that it will contain a maximum quantity of leucocytes. It is probably impossible to stimulate the formation of leucocytes so rapidly that the process would be available for immediate treatment in cases of acute poisoning, but, since it requires only four or five days to produce immunity to snake venom by repeated injections of a dilute solution of the chloride of lime, it might possibly be useful in chronic cases where the poison concerned is harmless when oxidized.

A particularly interesting phase of oxidation in relation to germicidal action has recently been investigated by Professors Freer and Novy at the University of Michigan. Their preliminary paper shows an interesting comparison of the germicidal effect of:

Hydrogen peroxide...... $H—O—O—H$.
Benzoyl peroxide....... $C_6H_5CO—O—O—COC_6H_5$.
Acetyl peroxide......... $CH_3CO—O—O—COCH_3$.
Benzoyl acetyl peroxide. $C_6H_5CO—O—O—COCH_3$

It will be noticed that the three organic compounds are symmetrical like that of hydrogen peroxide. The amount of available oxygen in each compound is the same but the germicidal action of each varies greatly. The use of hydrogen peroxide as a germicidal agent, especially in strong solution, is well known. Benzoyl peroxide is almost insoluble in water and is not hydrolyzed; it is therefore of no value as a germicide. The last two compounds have no germicidal value of themselves, but they are readily hydrolyzed in the presence of water yielding benzo peracid $C_6H_5CO—O—OH$, and aceto peracid $CH_3CO—O—OH$, both of which have a very marked germicidal value. These organic peracids or peroxides are, according to the authors, at least several hundred times more active than is hydrogen peroxide. The active oxygen content is the same in each, so that the difference in effect cannot be due to nascent oxygen. Hydrogen peroxide loses its available oxygen readily and even violently on contact with enzymes, but these organic peroxides do not. The authors were, therefore, forced to the conclusion that the difference in action is due to the behavior of the acid ions. In this case, therefore,

it is the benzoyl and the acetyl ions and not the oxygen which does the germicidal work.

In close connection with this investigation there is another recent piece of work suggestive of important problems in connection with the chemistry and physiology of plant poisons which I wish to allude to before closing, and that is the paper by Dr. A. P. Mathews entitled 'The Nature of the Nerve Impulse,' published in the March *Century*. This treats of nerve stimulation and nerve paralysis on the basis of our modern theories on the nature of solution, a trend of investigation now being carried on at the Hull Physiological Laboratory of the University of Chicago under the direction of Dr. Jacques Loeb, Professor of Physiology at the institution. The author's conclusions are as follows:

"It has been shown: first, that the chemical stimulation of protoplasm is really an electrical stimulation; second, that the poisonous action of inorganic salts is due to the electrical charges of the salts and probably to the movements of these charges: third, that the negative charges stimulate protoplasm, while the positive prevent stimulation, and if not counteracted by the negative will destroy life; fourth, that muscle contraction is probably in its essence an electrical phenomenon and that the conduction of a nerve impulse is almost certainly an electrical phenomenon; fifth, for the first time we have a physical explanation which agrees with all the main known facts of the nerve impulse and changes in irritability; sixth, we have secured a physical explanation of the way in which an anesthetic produces its effect; seventh, we are led to the hypothesis of the identity of stimulation by light and by chemicals."

The author does not, in this paper, discuss the possible effect of the ions of plant poisons, but it is difficult to see if his theory really holds good for organic compounds, why the complex cathion of so many alkaloids should be so extremely poisonous, and one is forced to wonder how any acid ion could be found which could be powerful enough to offset the toxic effect. One is also tempted to wonder if death can be the complete physiological opposite of life, for is there not a tremendous difference between the automatically reversible character of the cell protoplasm which enables it alternately and in rapid succession to solidify and redissolve, and the simple irreversible solid or liquid state which is the result of death?

In the foregoing paper I have attempted briefly to discuss some of the practical, as well as some of the theoretical, features of plant poisons, throwing out suggestive hints rather than concrete problems here and there, and although I feel that the ground has not been adequately covered, I trust that at least some of you have been interested in the discussion, and I venture to express the hope that some of the suggestions have fallen on good ground and will result some day in a rich harvest of facts giving solutions to some of the problems suggested.

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Washington, D. C.

SCIENTIFIC BOOKS.

Reports on Plans for the Extermination of Mosquitoes on the North Shore of Long Island, between Hempstead Harbor and Cold Spring Harbor. Published by the North Shore Improvement Association. 1902. Pp. 125.

This is an extremely interesting and in some ways a most remarkable publication. It is a sign of the times that a number of men interested in a given territory should form themselves into an improvement association whose principal aim seems to be to do away with the

mosquito pest, though that is not especially mentioned in the published list of objects. It is remarkable that, besides expending many thousands of dollars to attain that end, they should also publish their results at an expenditure of hundreds more, for the benefit of others contemplating similar improvements.

'Reports' contained in the volume are made by the Executive Committee; by their engineer, Mr. Henry Clay Weeks; by Professor N. S. Shaler, of Harvard University; by Professor Charles B. Davenport, of the University of Chicago, and by Mr. Frank B. Lutz, of the same place.

Professor Shaler deals chiefly with the matter of salt marshes, their value when reclaimed, the methods of reclamation and the crops that may be planted on such areas. The paper is an interesting one, general in its scope, without pretense to novelty, but informing in character.

Professor Davenport and Mr. Lutz, each with an assistant, report on the entomological work done, which consisted mainly of a thorough survey of the territory covered by the association, and the determination of the breeding places for mosquitoes of all kinds. *Culex* and *Anopheles* are nearly always lumped and specific terms rarely appear. There is nothing, therefore, to determine what species actually occur and what species are actually troublesome. The usual generalized life histories are given and the usual recommendations applied to the specific conditions are made. No original investigations seem to have been carried on and no novelty is claimed; the report is informing in its general character, and is a model of thoroughness within its scope. It is to be regretted that, especially in *Culex,* the species found breeding in the various localities are not determined. It is by no means certain that for practical purposes all mosquitoes should come under an equal ban, and nothing in the report shows whether the mosquitoes so often referred to were such as were breeding in the waters near by, where larvæ were found.

The report of the engineer is supplemented by an elaborate map on a scale sufficient to admit of the marking of all points where treatment is necessary or where engineering work is required. It is confined to the local problem and no generalizations are attempted.

Altogether the 'Reports' show a well-organized effort, intelligently carried out, which is bound to secure the desired results in due time. It may be a question whether the results could not have been obtained by a somewhat less elaborate and expensive organization; and it may be that the staff employed by its very excellence and the expense incurred may deter rather than encourage smaller or less wealthy bodies from embarking in similar works.

To secure general cooperation in the campaign against mosquitoes the methods must be of the simplest and cheapest that will prove effective. But on this latter point the 'Reports' deserve unqualified praise for the stand taken, that destruction of breeding places, not the never-ending destruction of larvæ, should be aimed at; that permanent works rather than merely palliative measures should be the aim of the asssociation.

JOHN B. SMITH.

NEW BRUNSWICK, N. J.,
June 12, 1902.

Researches on Cellulose, 1895–1900. By CROSS & BEVAN. London, New York and Bombay, Longmans, Green and Co. 1901. 8vo. Pp. 180.

The first work on cellulose by these authors, published in 1895. was an attempt to bring together into convenient shape, and, as far as possible, into logical arrangement, the scattered and largely unclassified knowledge on this important subject. That they made an excellent beginning in bringing order out of chaos few investigators familiar with the subject will deny. The first work has been and is of decided value both to the scientific and the industrial worker. The present volume reviews the researches on cellulose from 1895 to 1900. The matter is arranged under the following sections: Introduction, dealing with the subject in general outline; Section I., 'General Chemistry of the Typical Cotton Cellulose'; Section II., 'Synthetical Derivatives—Sulphocarbonates and Esters'; Section III., 'Decompositions of Cellulose such as

throw Light on the Problem of its Constitution'; Section IV., 'Cellulose Groups, including Hemicelluloses and Tissue Constituents of Fungi'; Section V., 'Furfuroids, *i. e.*, Pentosanes and Furfural-yielding Constituents Generally'; Section VI., 'The Lignocelluloses'; Section VII., 'Pectic Group'; Section VIII., 'Industrial and Technical; General Review'; Index of authors; Index of subjects.

The authors should be highly commended for their appreciation and treatment of the practical industrial problems connected with cellulose. Pure science is not lowered in the estimation of most men because it may have practical bearings, and it is almost needless to say that some of the greatest advancements in scientific knowledge have been brought about by men who had an eye for the practical as well as the scientific side of investigations. The subject is developing rapidly at the present time from both the scientific and the practical side, and it certainly offers an inviting field for students of chemistry who wish to make their work count for something in the commercial as well as the scientific world.

A. F. WOODS.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Journal of Comparative Neurology* for June contains the following articles: (1) 'Number and Size of the Spinal Ganglion Cells and Dorsal Root Fibers in the White Rat at Different Ages,' by S. Hatai. The number of spinal ganglion cells does not change with age, though some small cells become large cells and the number of dorsal root fibers increases. (2) 'Observations on the Medulla Spinalis of the Elephant with some Comparative Studies of the Intumescentia Cervicalis and the Neurones of the Columna Anterior,' by I. Hardesty. In addition to the histological examination of the elephant, there is a similar study of the spinal cords of a series of twelve mammals of diminishing body weights, with statistics of the ratios to body weights of the dimensions of the spinal cord and ventral horn cells. (3) 'Observations on the Post-mortem Absorption of Water by the Spinal Cord of the Frog,' by H. H. Donaldson and Daniel M. Schoemaker. There is a post-morten absorption of water by the spinal cord of *Rana virescens* amounting sometimes in 24 hours to 25 per cent. of the normal weight of the cord. The conditions under which this absorption takes place were experimentally studied. (4) 'Observations on the Developing Neurones of the Cerebral Cortex of Fœtal Cats,' by S. Hatai. Confirms Paton's observation that the dendrites develop before the neurites or axones. The usual literary notices complete the number.

THE contents of the *American Journal of Mathematics* for July, 1902, are as follows:

'Die Typen der linearen Complexe elliptischer Curven im R_r,' von S. Kantor; 'Generalization of the Differentiation Process,' by Robert E. Moritz; 'Simple Pairs of Parallel *W*-Surfaces,' by Henry Dallas Thompson.

SOCIETIES AND ACADEMIES.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

WE have received preliminary lists of the papers to be presented before three sections of the Pittsburg meeting of the American Association for the Advancement of Science, as follows:

SECTION C AND THE AMERICAN CHEMICAL SOCIETY.

Tuesday, July 1, 1902.

'Valence': IRA REMSEN.

'The Ozone from Potassium Chlorate': EDWARD HART.

'Electric Combustion': EDWARD HART.

'The Chlorides of Ruthenium': JAS. LEWIS HOWE.

'Electrolytic Deoxidation of Potassium Chlorate': WILDER D. BANCROFT.

'The Solid Phases in Certain Alloys': WILDER D. BANCROFT.

'An Improved Grinder for Analysis of Motherbeets': DAVID L. DAVOLL, JR.

'The Electrical Conductivity and Freezing Points of Aqueous Solutions of Certain Metallic Salts of Tartaric, Malic and Succinic Acids': O. F. TOWER.

'Recent Progress in the Fireproofing Treatment of Wood': SAML. P. SADTLER.

'Ionic Velocities in Liquid Ammonia Solutions': E. C. FRANKLIN.

'The Expansion of a Gas into a Vacuum and the Kinetic Theory of Gases': PETER FIREMAN.

'Quantitative Blowpipe Analysis by Bead Colorations': JOSEPH W. RICHARDS.

'Solubility, Electrolytic Conductivity, and Chemical Action in Liquid Hydrocyanic Acid': LOUIS KAHLENBERG and HERMAN SCHLUNDT.

'Determination of Glucose': EDWARD GUDEMAN.

'Gluten Feed Analyses': EDWARD GUDEMAN.

'Arsenic Pentachloride': CHARLES BASKERVILLE and H. H. BENNETT.

'Black Rain in North Carolina': CHARLES BASKERVILLE and H. R. WELLER.

'A New Method for the Preparation of Pure Praseodymium Compounds': CHARLES BASKERVILLE and J. W. TURRENTINE.

'Deportment of Pure Thorium and Allied Elements with Organic Bases': CHARLES BASKERVILLE and F. H. LEMLY.

'A New Constant High Temperature Bath': CHARLES BASKERVILLE.

'A Process for Rendering Phosphoric Acid Available': CHARLES BASKERVILLE.

'Molecular Attraction': J. E. MILLS. (By title.)

'Condensation of Chloral with the Nitranilines': A. S. WHEELER and H. R. WELLER.

'The Composition of Urine and its Relation to Electrical Conductivity': JOHN H. LONG. (By title.)

'Symmetrical Trimethylbenzyl, Symmetrical Trimethylbenzol Hydrazone and some of its Derivatives': EVERHART P. HARDING.

'1. 4. Dimethylbenzyl, 1. 4. Dimethylbenzol Hydrazone and some Derivatives': EVERHART P. HARDING.

'The Action of Valerianic Acid and Valeric Aldehyde upon Antipyrin': DAVID C. ECCLES.

'On Conductivity': GEORGE A. HULETT.

'Relation between Negative Pressure and Osmotic Pressure': GEORGE A. HULETT. (By title.)

'Comparison of Results Obtained by Different Methods of Determining the Amount of Oxygen Absorbed by Waters Containing Oxidizable Substances': LEONARD P. KINNICUTT.

'The Old and the New in Steel Manufacture': WM. METCALF.

'Some Notes on Glass and Glass Making': ROBERT LINTON.

'Manufacture of Optical Glass': GEORGE A. MACBETH.

'Bessemer and Open-Hearth Steel Practice': EDWARD H. MARTIN and WM. BOSTWICK.

'Malleable Iron': H. E. DILLER.

'Manufacture of Plate Glass': FRANCIS P. MASON.

'Manufacture of White Lead': GERARD O. SMITH.

'Camphoric Acid: Synthesis of Trimethylparaconic Acid': W. A. NOYES and A. M. PATTERSON.

'The Hydrolysis of Maltose and Dextrine for the Determination of Starch': W. A. NOYES, GILBERT CRAWFORD, C. H. JUMPER, E. L. FLORY.

'Crucible Steel Manufacture': E. L. FRENCH.

SECTION D, MECHANICAL SCIENCE AND ENGINEERING.

'The Trend of Progress in Prime Movers': Director R. H. THURSTON, Cornell University.

'On Changes in Form as an Essential Consideration in the Theory of Elasticity': Mr. FRANK H. CILLEY, Brooklyn.

'On the Advantage of Siamesed Hose Lines for Fire Steamers': Professor MANSFIELD MERRIMAN, Lehigh University.

'The Nomenclature of Mechanics': Professor R. S. WOODWARD, Columbia University.

'U. S. Work in the Ohio, Allegheny and Monongahela Rivers near Pittsburg': Mr. THOMAS P. ROBERTS, Pittsburg.

'On a Type of Planetary Orrery Using the Mechanical Principle of the Conical Pendulum': Professor DAVID P. TODD, Amherst College.

'On the Ratio of the Transverse to the Longitudinal Elastic Strain Produced by Longitudinal Stress': Professor THOMAS GRAY, Rose Polytechnic Institute, Terre Haute, Ind.

'On the Effect of Hardening Steel on its Young's Modulus': Professor GRAY.

'A Test of a Ball Thrust Bearing': Professor GRAY.

'A New Photometer, with Exhibition of the Instrument': Professor C. P. MATTHEWS, Purdue University.

'The Mechanics of Reinforced Concrete Beams': Professor W. K. HATT, Purdue University.

'Some Experiences with a Simple Babbitt Testing Machine': Mr. E. S. FARWELL, New York City.

'The Rules and Regulations Concerning Airship Contests at the Louisiana Purchase Fair': Professor C. M. WOODWARD, Washington University, St. Louis.

'Long Distance Electric Transmission Regarded as a Hydrodynamic Phenomenon': Professor H. T. EDDY, University of Minnesota.

'The Effect of Weeds and Moss upon the Co-

efficients of Discharge in Small Irrigating Canals': Professor J. C. Nagle, College Station, Texas.

It is expected that an evening illustrated stereopticon lecture will be given before this section by Captain Sibert upon the bridges and other interesting structures of the Philippines.

The first excursion of the Section will probably be on Tuesday afternoon, July 1, to the famous Carnegie Homestead plant. Other excursions to similar points are arranged and will be available to the members of the Section to any extent desired.

SECTION H, ANTHROPOLOGY.

Monday, June 30, 1902.

'Address of Retiring Vice-President': J. Walter Fewkes.

'The Human Effigy Pipe, taken from Adena Mound, Ross Co., Ohio': Wm. C. Mills.

'Burials of Adena Mound': Wm. C. Mills.

'Gravel Kame Burials in Ohio': W. K. Moorehead.

'Microscopical Sections of Flint from Flint Ridge, Licking Co., Ohio': Wm. C. Mills.

'Explorations of 1901 in Arizona': Walter Hough.

'The Throwing Stick': George H. Pepper.

'A Collection of Crania from Gazelle Peninsula, New Britain': George G. MacCurdy.

'Climatic Changes in Central Asia traced to their Probable Causes and Discussed with Reference to their Bearing upon the Early Migrations of Mankind': G. Frederick Wright.

'Dr. Thomas Wilson's Career at Washington': W. K. Moorehead.

'Anthropological Museums in Central Asia': G. Frederick Wright.

'Anthropological Museums and Museum Economy': Stewart Culin.

'Classification and Arrangement of the Collections of an Anthropological Museum': W. H. Holmes.

'Methods of Collecting Anthropological Material': Harlan I. Smith.

'Preservation of Museum Specimens': Walter Hough.

July 2 and 3, meeting with the American Folk-Lore Society.

BIOLOGICAL SOCIETY OF WASHINGTON.

The 357th meeting, the last of the season, was held on Saturday evening, May 31.

D. E. Salmon and C. W. Stiles presented a communication, made by Dr. Stiles, on 'Surra, a Disease in the Philippines of Great Military Importance.' The speaker stated that the disease known as surra has been diagnosed among the horses in the Philippines, and has led to the prohibition of landing any animals from those islands at any ports of the United States or of the dependencies thereof.

This disease is caused by a microscopic parasite (*Trypanosoma Evansi*) which lives in the blood, and the evidence now accessible indicates that this organism is transmitted by means of biting flies, especially by members of the genus *Tabanus* (horse-flies); other methods of dissemination are not excluded. It is chiefly a wet-weather disease, and is reported as invariably fatal to horses and mules. It occurs in other animals—such as camels, elephants, dogs, cats, etc.—more rarely in ruminants, and may be transmitted to goats, sheep and other mammals, but is not yet reported for birds. It is more or less common in India. Its introduction into the Philippines is unexplained, but it has probably existed there for some years past.

Parasites closely allied to this species occur in Europe, Africa and South America, in some cases causing disease known as tsetse-fly disease, dourine, mal de caderas, and rat trypanosomiasis. Certain authors believe that some of these maladies are identical with surra.

The chief symptoms of surra are fever, of an intermittent, and sometimes relapsing type; urticarial eruption; petechiæ on the mucous membranes; progressive anemia and emaciation; ravenous appetite and extreme thirst; more or less paralysis.

Treatment has not been satisfactory, but arsenic has been followed by good results in some cases. Prevention is difficult, but should consist in protecting horses from flies. Immediate isolation of the sick animals and protecting them from flies will result in restricting the disease. In some cases it will perhaps

be better to kill and immediately destroy the diseased animals.

From both the military and economic points of view surra must be looked upon as a very serious matter, and its introduction into the United States would result in very heavy losses.

Barton W. Evermann spoke on 'The American Species of Shad,' stating that from time to time reports had been received by the U. S. Fish Commission of the capture of shad in the Mississippi basin, but that these reports had proved either to have no foundation or to be based on some other fish. In 1897, however, Mr. James Sowders, of Louisville, forwarded four specimens of a true shad, saying that he had taken a few each year for many years past, but that only recently had he captured them in any number. The specimens proved to be a new species, which has been named *Alosa ohiensis;* it is more slender than the Atlantic shad, and has fewer gill rakers while it is much more slender than the Alabama shad and has more gill rakers than that species.

F. A. LUCAS.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of June 2—sixteen persons present—Professor A. S. Langsdorf described the factory tests that are made on electrical machinery, illustrating the subject by lantern diagrams showing the circuits employed for the various tests, and by pictures of the machines as set up for testing in the factory.

A biographical sketch of the late Dr. A. Litton, one of the first members of the Academy, by Dr. G. C. Broadhead, was presented by Dr. Hambach.

Mr. H. A. Wheeler spoke of the occurrence, at Hematite, Mo., some forty miles below St. Louis, of a number of granite boulders, some of them showing the polishing action of ice; and accounted for their occurrence at this point, or some fifty miles beyond the southern limit of the terminal moraine, by the theory that they had been carried there on cakes of ice during the Loess period.

Mr. Wheeler and Professor Nipher discussed a recent newspaper account of the alleged finding of a meteorite that was recently seen to fall in St. Louis, and agreed that the supposed meteorite, which both of them had examined, was merely a pyrite concretion from the coal measures, of the type called 'sulphur-balls' or 'nigger-heads,' which had probably been raked out from the grate-bars of the adjoining factory, and passed off on its discoverer as a meteorite.

Four persons were elected to active membership.

WILLIAM TRELEASE,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

THE EXPLOSIVE FORCE OF VOLCANOES.

TO THE EDITOR OF SCIENCE: Mr. A. E. Verrill's hypothesis as to the explosive forces of volcanoes, published in your columns, May 23, 1902, was most interesting.

His theory as to the disassociation of the hydrogen and oxygen of the water penetrating by submarine channels to the base of the volcanoes accounts for many of the phenomena. The separation is not immediate, but the water is probably first converted into steam; this is then superheated and the oxgyen is burned out and the hydrogen liberated expands with terrific force and its further heating gives it increased power. This would account for the groanings and rumblings in the mountain itself before the outbreak. When the mass of overlying matter is no longer heavy enough to resist the immense internal pressure, it gives way and a violent explosion or rather cyclonic expansion of the imprisoned gases results. This expansion is upwards, downwards and outwards, following the lines of least resistance. The surrounding atmosphere is at first pushed back with a rush, but simultaneously there is an effort towards readjustment. The superheated hydrogen at once seeks to combine with the cooler oxygen, and in the process of readjustment frequent discharges and flashes of flame are seen which explode the mixture of hydrogen and atmospheric air in combination. The process is now reversed and, instead of expansion, we have immediate contraction and condensation. Water is at once

formed and it concentrates around the dust particles and falls in a rain of mud. The reports show that the mud fell, not near the crater, but along the lower part of the mountain.

As soon as the outrushing hydrogen could combine with the oxygen of the air to form water, an immediate contraction followed. A vacuum was formed extending over areas in proportion to the volume of hydrogen ejected, and combined with the atmosphere. Hurricane phenomena on a gigantic scale were at once witnessed. Trees were uprooted and the walls of houses were pulled outwards. The clothes of the victims were torn off. The garments had acted like the screens on the Davy safety lamp—they had prevented the air between body and clothes from combining with the hydrogen, but as soon as the vacuum caused by the combination on their exterior took place they were exploded and torn off by the contained air. The extensive vacuum thus formed might also account for the sudden death of the victims, the instantaneous removal of the atmospheric pressure causing cerebral hemorrhage and paralysis. Autopsies upon the bodies of the victims would have determined the immediate cause of death. If none have been made they might still be made where the bodies were well covered.

In the absence of other demonstrable causes the tidal wave may also be accounted for on the same theory. ROB'T H. GORDON.

CUMBERLAND, MARYLAND,
June 7, 1902.

SHORTER ARTICLES.

BLACK RAIN IN NORTH CAROLINA.

THE 'famous black rain,' so-called by the natives, fell at Louisburg, N. C., the morning of March 15, 1900.

A sample of the water which had been carefully collected came into our hands through the kindness of Professor M. S. Davis, of the Louisburg Female College. An analysis was made:

	Parts per Million.
Total residue	88.00
Loss on ignition	54.00
Non-volatile residue	34.00
Chlorine	19.144
Oxygen consuming power—15 minutes	1.93
Oxygen consuming power—4 hours	2.64
Ammonia—free	.872
Ammonia—albumenoid	.04
Nitrogen as nitrates	.88
Nitrogen as nitrites	none.

About sixty per cent. of the residue was organic matter, largely soot. The chlorine content showed an unusual amount of sodium chloride. The non-volatile residue besides sodium and some calcium gave reactions for traces of iron, manganese, aluminum and zinc. The other constituents indicate ordinary rain water.

No especial phenomena were noted preceding or during the precipitation 'except an unusually black cloud and a heavy downpour of rain, accompanied by a darkness so dense as to necessitate the use of lamps for half an hour.' It had been raining for several days preceding this occurrence and the water collecting in pools out of doors showed a distinct and unusual black color. A number of samples were collected and held as a curiosity. After a few days the water became clear through the settling of a black sediment.

The situation of and amount of fuel burned in the place, as well as the time of the year, preclude accounting for the fluorescent black rain by local contamination, such as observed in numerous cases by Angus Smith and Phipson and lately by Irwin, who examined the snowfall in Manchester, England (*Journ. Soc. Chem. Ind.*, XXI., 533, 1902). While it is well known the unusual impurities in rain, snow, etc., often occur and the sources of contamination may be traced great distances, no opinion is hazarded as to the cause of this phenomenon. All such incidental observations deserve chronicling, as did the black snow which fell in Indiana in January, 1895 (*Monthly Weather Review*, 60, 19), the 'blood rain' reported by Passerine to have fallen at Florence in March of last year (*L'Orosi*, 24, 325), and the 'dust fall' in Europe the same month (reported by Hellmann and Meinardus).

CHAS. BASKERVILLE,
H. R. WELLER.

UNIVERSITY OF NORTH CAROLINA.

THE RANGE OF THE FOX SNAKE.

TO THE EDITOR OF SCIENCE: Cope (*Rept. U. S. Nat. Mus.*, 1898, p. 832) gives the range of the fox snake, *Coluber vulpinus* B. & G., as 'distributed over the northwest of the eastern district, not being known from east of Illinois or south of the mouth of the Missouri River.' Dr. J. A. Allen in 1869 (*Proc. Bos. Soc. Nat. Hist.*, 12, 171 ff.) mentioned a specimen of this snake taken in the vicinity of Wenham, Mass., in 1861. Cope apparently overlooked this record. Eckel, in his recently published 'Catalogue of the Reptiles of New York' (Bull. 51, N. Y. State Museum), gives it a doubtful place on the strength of this record of Dr. Allen's.

Aside from this single case, no record has been made, to my knowledge, of the occurrence of this snake in any state east of Illinois with the exception of Ohio. In the vicinity of Sandusky, east and west along the lake, the fox snake is found. On Cedar Point —a tongue of sand twelve miles long and a few hundred yards wide at best—several specimens have also been taken. The specimens from these localities are in the Zoological Museum of the Ohio State University.

Owing to the fact that several species of plants and animals of pronounced western type have been found in this region, it appears that this may form an eastward arm of the zoogeographical as well as the phytogeographical district to the west. Hence, any information as to the occurrence of the fox snake east of Illinois will be welcomed by the undersigned.

MAX MORSE.

OHIO STATE UNIVERSITY.

A PROPOSED AMERICAN ANTHROPOLOGIC ASSOCIATION.

DURING the Convocation Week of 1901–1902, there were meetings of the Section of Anthropology of the American Association for the Advancement of Science, the American Folk-Lore Society, and several other organizations, in Chicago. In connection with these meetings there was, on December 31, a conference of committees on the needs of American anthropology appointed by the Anthropological Society of Washington, the American Ethnographical Society, and the Section of Anthropology of the A. A. A. S. The participants in the conference were Franz Boas, Stewart Culin, Roland B. Dixon, George A. Dorsey, Livingston Farrand, J. Walter Fewkes, George G. MacCurdy, W J McGee, Frank Russell, and Frederick Starr. Although little constructive action was taken at Chicago, the conference resulted in a general feeling that more definite cooperation among American anthropologists would be advantageous.

Subsequently several of the conferees engaged in correspondence pursuant to the deliberations in Chicago, which soon served to bring out and strengthen the feeling that some sort of organization was needful; and in the course of a few weeks preliminary steps were taken toward the formation of an association of American anthropologists of national character. The most important action was the selection of a number of prospective founders of the proposed association, from whom expressions were invited. Most of the anthropologists so addressed have replied, and nearly all of these decidedly favor organization. Accordingly, arrangements have been made for a founding meeting, to be held at Pittsburgh in connection with the meeting of the American Association for the Advancement of Science, in the audience room of Bellefield Church, on Monday, June 30, at 2 o'clock P.M. Provisional arrangements are also under way for a scientific meeting of the new organization in connection with Section H (Anthropology) of the A. A. A. S. on Wednesday, July 2.

The most serious question brought out in the preliminary correspondence and conferences is, Shall the new association be strictly professional or of more general character? With the view of holding the settlement of this question in abeyance pending the completion of the organization, it was thought better by the Chicago conferees to limit invitations to the founding meeting to about forty of the leading anthropologists of the country. The invitations are now being sent

out by Dr. George A. Dorsey, of the Field Columbian Museum. W J M.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The American Association for the Advancement of Science holds its fifty-first annual meeting at Pittsburgh from June 28 to July 3, and in affiliation with it a number of scientific societies hold their meetings. Announcements in regard to the meetings will be found in the issue of Science for May 23. Letters in regard to the meeting may be addressed to the permanent secretary, Dr. L. O. Howard, Hotel Schenley, Pittsburgh, Pa., or to the local secretary, Mr. George A. Wardlaw, Post-office Box 78, Station A, Pittsburg.

SCIENTIFIC NOTES AND NEWS.

Dr. William H. Forwood has succeeded Dr. George M. Sternberg as surgeon-general of the army. His services during and since the Civil War have been distinguished, and he is the author of important contributions to military surgery and of papers on natural science. Dr. Forwood is brigadier-general and senior officer in the medical department of the army. His retirement under the age limit will occur next Saturday.

The dinner in honor of Surgeon-General George M. Sternberg, to which we have called attention, occurred in New York on June 13. Addresses were made by Dr. E. G. Janeway, Dr. A. H. Smith, Colonel Henry Lippincott, Dr. William Osler, Major W. C. Gorgas, Dr. John A. Wyeth, Dr. Frank Billings and Dr. W. H. Welch. Dr. Sternberg also spoke.

At its recent commencement exercises Princeton University conferred the degree of LL.D. on Dr. H. F. Osborn, professor of zoology at Columbia University.

President Henry Smith Pritchett, of the Massachusetts Institute of Technology, gave the convocation address at the University of Chicago on June 15.

Dr. J. Walter Fewkes, of the Bureau of American Ethnology, has just returned from a successful ethnologic and archeologic reconnaissance of Porto Rico.

Dr. Frank Russell has brought to a close a year's work in Arizona under the auspices of the Bureau of American Ethnology. Some months were spent in archeologic reconnaissances and surveys; since January he has been occupied with studies of the sociology and mythology of the Pima Indians at Sacaton and elsewhere. Dr. Russell will resume his work in Harvard during the autumn.

Dr. Albert E. Jenks, ethnologist in the Bureau of American Ethnology, sailed from San Francisco on the 15th instant for Manila, pursuant to a transfer of a year to the Philippine service. He will be associated with Dr. David P. Barrows, chief of the Philippine Bureau of Non-christian Tribes.

Assistant Professor Oscar Quick, of the Department of Physics, University of Illinois, Urbana, Illinois, has resigned his position to go into practical electrical engineering work.

The Pathological Institute of the University of Prague will celebrate next year the twentieth anniversary of the directorship of Professor Hlava. A commemorative volume is in preparation.

Mr. E. Cunningham, St. Johns College, is this year senior wrangler at Cambridge.

The Paris Academy of Sciences has sent M. Lacroix, of the Museum of Natural History; M. Rollet de Lisle, the engineer, and M. Giraud, the geologist, to investigate the effects of the volcanic eruption in the Lesser Antilles. They embarked on June 9, and will spend several months on the islands.

The Loubat prize for 1902 has been awarded by the Swedish Royal Academy of Literature, History and Antiquity to Mr. C. V. Hartman for his publications concerning his archeological and ethnological researches in San Salvador and Costa Rica.

In honor of the late Alpheus Hyatt a memorial fund is being collected for field lessons in natural history. Professor Hyatt was greatly interested in extending the teaching of natural history to the schools and this memorial appears to be especially appropriate. While the fund will be administered by a board of trustees at Boston contributions from Professor Hyatt's former pupils or friends, wherever

living, will be welcome. The president of the trustees is Professor William H. Niles, of the Massachusetts Institute of Technology, and the treasurer, to whom subscriptions may be sent, is Mr. Stephen H. Williams, 2 Tremont street, Boston, Massachusetts.

DR. WYETH JOHNSON, recently appointed professor of hygiene at McGill University and dean of the Medical School, died at Montreal, on June 19.

DR. RICHARD BURTON ROWE, of the U. S. Geological Survey, died of consumption in the hospital at Los Angeles, Cal., on May 26, at the age of thirty years. Dr. Rowe was a graduate of Union College and Johns Hopkins University. His home was at Clarksville, Albany County, N. Y.

MAJOR OSCAR CHAPLIN FOX, since 1873 examiner in the U. S. Patent Office, and a fellow of the American Association for the Advancement of Science, died on June 7, at the age of seventy-two years.

THE Rev. Doctor Anson Judd Upson, chancellor of the University of the State of New York, died on June 15, in his seventy-ninth year.

CONGRESS has just made an additional appropriation of $75,000 for the buildings of the National Bureau of Standards. The cost of the buildings as now planned is $325,000.

HERR BECK-GAMPER has given 750,000 francs to the Zoological Garden at Basel.

THE Duc de Chartres, in memory of his son, Prince Henry, has given the Paris Geographical Society 11,000 francs, the interest of which shall be given every three years for a journey for economic study and geographical exploration in Asia.

M. HENRI SCHNEIDER gave before his death $7,000 to the French Society of Civil Engineers for seven prizes to be awarded for the best books in different departments of engineering published in France during the last forty years. The books entered for competition must be received by the society not later than the end of the present month.

THE bill transferring certain forest reserves to the Department of Agriculture has been defeated in the House by a vote of 100 to 70.

ATTORNEY-GENERAL DAVIES has decided that the Cornell School of Forestry has not violated any provisions of law on the land held by it in the Adirondack preserve, and he has made public an opinion in which he holds that there exists no cause for the beginning of an action to dispossess Cornell University from lands which the college holds for forestry purposes.

THE annual *conversazione* of the Institution of Civil Engineers was held on June 4. Mr. Charles Hawksley (president), and Mrs. Hawksley, supported by Sir John Wolfe-Barry, Sir Benjamin Baker, Sir Frederick Bramwell, Sir William Preece, Sir Douglas Fox, Sir Alexander Binnie, and Sir G. Molesworth (members of the council) received about 1,500 guests.

W. S. CHAMP, secretary of the Baldwin-Ziegler Arctic expedition, and Dr. G. Shurkley, of New York, started on June 13 for Tromsö, Norway, whence they will sail on July 1 on the *Frithjof* for Franz Josef Land to take coal to Mr. Baldwin's ship, the *America*, and obtain news of the explorer. Mr. Champ expects to find the *America* in about 82 degrees. If Mr. Baldwin has succeeded in his dash to the pole he will be brought back. Otherwise the *Frithjof* will leave a well equipped sledge party to search for Mr. Baldwin. The *Frithjof* will return on October 1 at the latest.

PROFESSORS R. A. S. REDMAYNE and T. Turner, who hold respectively the chairs of mining and metallurgy in the University of Birmingham, are at present in America investigating our technological schools with a view to the arrangement of their departments at Birmingham. In the Montreal daily *Star*, a copy of which a correspondent has sent us, Professor Redmayne is quoted as saying: "In no part of England, nor anywhere on the continent, in fact, can you find a school of mining or a department of metallurgy in any university that can in any way compare with those to be found in Canadian and American universities. Strange to say, these departments in the universities of the old country are so incomplete that up to the present it has been found necessary, if one

wanted to obtain a thorough technical training, to come to America. To change the present condition of affairs in England is the object of our present visit."

AT a meeting of the Zoological Society of London on June 3 Mr. William Sclater made some remarks on the present condition and future prospects of the zoological museums of South Africa, altogether eight in number, most of which he had recently visited.

THE city of Waukesha, Wisconsin, as a result of a condition of a recent election, has purchased the Cutler property in that city for use as a library and park site to enclose and preserve the three prehistoric mounds situated thereon. The efforts of the Wisconsin Natural History Society were largely instrumental in bringing about this result.

THE Canadian Electrical Association held its twelfth annual convention at Quebec on June 11, 13 and 14.

AN International Navigation Congress will be held at Düsseldorf from June 29 to July 5.

THE American Roentgen Ray Society will hold its next meeting in Chicago on December 10 and 11, under the presidency of Dr. G. P. Girdwood, of Montreal.

THE program for the Section of Science at the approaching meeting of the National Educational Association is:

'President's Address': W. H. NORTON, Professor of Geology, Cornell College, Iowa.

'The Educational Value of Museums': OLIVER C. FARRINGTON, Field Columbian Museum, Chicago.

'The Projection Microscope; its Possibilities and Value in Teaching Biology': Professor A. H. COLE, Lake High School, Chicago.

'The International Geographical Congress to be held in Washington under the Auspices of the National Geographic Society, 1904': GILBERT H. GROSVENOR, Managing Editor *National Geographic Magazine*, Washington.

'Laboratory Courses in Physics': FRANK M. GILLEY, High School, Chelsea, Mass.

'The Value of Physiography in the High School': Professor J. A. MERRILL, State Normal School, West Superior, Wisconsin.

'Federal Facilities for Education': Dr. W J McGEE, Ethnologist in charge Bureau of American Ethnology, Washington.

WE announced last week a civil service examination to fill twelve vacancies in the position of aid in the U. S. Coast and Geodetic Survey. We have received a copy of a letter by Mr. O. H. Tittmann, superintendent of the Survey, containing the following further explanation: The rank of aid is the lowest or entering rank leading to the position of assistant to the superintendent. The Coast and Geodetic Survey is engaged in a great variety of duties and its operations extend over a vast range of territory. The aids, like the assistants, are subject to assignment either as chiefs of party or subordinate officers on parties engaged in the determination of the magnetic elements, in secondary triangulation and astronomical determinations for the control of topographic and hydrographic surveys, in primary triangulation and the corresponding astronomical determinations, in topographic surveying along the coast and in hydrographic surveys in the bays or harbors and in the open sea. The steamers and sailing vessels belonging to the Survey are commanded by these members of the permanent field force. During the intervals between field seasons assistants and aids are subject to assignment to office duty in Washington, or in one of the sub-offices at Seattle, San Francisco, Honolulu or Manila. Nearly all administrative positions in the office at Washington, from that of chief of division to the highest rank, are open to and are now filled by assistants. The duties of the field officers take them to all parts of the United States, including Porto Rico, Alaska, Hawaii and the Philippines. The members of the permanent field force have, therefore, a very wide range of duties as surveyors engaged in the highest grades of surveying, as navigators and as scientists, and have a rare opportunity for extensive travel and acquaintance with the world. The aid is subject to assignment to any duty required of any other officer of the permanent field force. In general the exigencies of the service place the aids so promptly in responsible positions that there is an abundant opportunity

for a man of exceptional ability to become known. Aids are appointed at a salary of $720 per year. The next step in the line of promotion is to the salary of $900 as aid, and thence to assistant at $1,200, and then upward by steps of $200 each. These statements of salary are misleading unless taken in connection with the fact that necessary traveling expenses incurred in the line of duty are paid by the government, and that in addition to his salary he is paid an allowance for subsistence to cover the ordinary living expenses while on field duty. During this period the allowance for subsistence is from $1.00 a day for an officer living on shipboard or in camp in quarters furnished by the government, to $2.50 a day for a chief of party living at a hotel or other quarters not furnished by the Government. All appointments to the position of aid are made from a Civil Service examination.

The Sixth Annual Report of the New York Zoological Society is most creditable to the Society in general and the director in particular. It not only shows very rapid progress in the laying out of the grounds and the erection of new buildings, but progress in the care of animals and in the control of disease among them; this in spite of the loss of several anthropoid apes. The death of these animals was found to be caused by an infusorian, *Balantidium coli*, introduced with the Galapagos tortoises, and harmless to them, while fatal to the large apes. The diseases of the animals are discussed at length in the reports of the veterinarian and pathologist, and the statement is made that little loss has been caused by tuberculosis, although this usually causes a large proportion of the deaths among animals in captivity. Mr. Ditmars gives an interesting account of the giant tortoises from the Galapagos, Mr. Beebe describes the 'Success of the Indoor Flying Cage,' Madison Grant tells of 'The Society's Expedition to Alaska,' and Mr. Loring presents some 'Notes on the Destruction of Animal Life in Alaska,' and gives an annotated list of 'Mammals and Birds observed in Southern Alaska in 1901.' The report is well illustrated and contains articles both of scientific value and of interest to the general reader.

As a result of a series of experiments begun at Clemson College in 1901 and brought to a successful completion in the laboratories of the New York Botanical Garden Dr. Alex. P. Anderson has developed a method by which, with the application of heat to starch grains and to air-dry starch in many forms, the granules or particles are expanded to many times their original dimensions, being fractured into innumerable fragments during the process. As a result of this treatment a grain of rice is expanded to eight or more times its original volume, while still retaining its original form. Other cereals exhibit similar behavior. The process is applicable to nearly all starchy seeds and starchy substances, greatly increasing their nutritive availability. The products obtained are pleasant to the taste, and the process may be varied to produce a great variety of flavors with any given cereal. Furthermore the material prepared in this manner is absolutely sterilized and may be preserved or stored for long periods. The approval the products have met from food and chemical experts suggests that the process may prove of great economic and commercial value.

THE London *Times* states that a London auctioneer has sold a collection of birds' eggs, among which was included the final portion of the collection of the late Mr. Philip Crowley, and also a collection from the cabinets of Mr. H. Noble. The most important lot in the sale was probably the finest known egg of the extinct moa, from New Zealand, which, however, did not reach the reserve price at £200. The last egg of this bird was offered at Stevens' about 20 years ago, and this was bought in at 200 guineas; it was returned to New Zealand, but eventually passed into the possession of an English collector at about 250 guineas. An egg of the *Kpyornis maximus*, the largest specimen ever offered, realized 38 guineas, and two eggs of the pectoral sandpiper, one from Alaska, £8 18s. 6d. These are the only eggs of this bird ever offered for sale in England. Four exceptionally large eggs of the golden eagle varied from 55s. to 75s. each.

UNIVERSITY AND EDUCATIONAL NEWS.

At the commencement exercises of the University of Pennsylvania, Provost Harrison announced that Mr. Joseph Wharton, founder of the Wharton School of Finance and Economy at the University, had increased his endowment of the school from $200,000 to $500,000.

Pennsylvania State College has received $100,000 from Mr. Andrew Carnegie for a library; $60,000 from Mr. and Mrs. Charles M. Schwab for an auditorium; and $20,000 from Mr. James Gilbert White for the establishment of a fellowship and three scholarships.

The sum of $100,000 has been collected for Smith College, thus securing the $100,000 promised by Mr. John D. Rockefeller.

A friend of the Massachusetts Institute of Technology, whose name is withheld, has given to that institution $5,000 a year for three years, to be devoted to investigation and instruction in sanitary science and the sanitary arts, especially the purification of sewage and water, and the disposal of garbage and other wastes of modern life. The work to be done will be under the direction of Professor W. T. Sedgwick, the head of the biological department of the Institute, and formerly biologist to the State Board of Health of Massachusetts.

Mrs. Sarah A. Rand has bequeathed $5,000 to Radcliffe College and the residue of her estate to the Boston Museum of Fine Arts.

Plans to expend $1,200,000 on a secondary school quadrangle at the University of Chicago have been announced by President Harper. The new group, of which the school of education building already in course of erection will be part, will include several buildings, all of which will be devoted to secondary education. Ground has been broken for the new manual training schools, and the other structures will be built as the expected endowments are received.

Franklin and Marshall College, Lancaster, Pa., dedicated its new Science Hall on June 11, when Professor Edgar F. Smith, of the University of Pennsylvania, delivered the chief address. The building was erected at a cost of about $80,000.

The University of Sydney, New South Wales, will celebrate in September its fiftieth anniversary.

Professor George H. Denny has been installed as president of Washington and Lee University. He graduated from Hampden-Sydney College in 1891, and has been professor of Latin at Washington and Lee University since 1899. The addresses of greeting at the installation included speeches by President Remsen, of the Johns Hopkins University, and President Venable, of the University of North Carolina.

Professor Charles W. Needham, dean of the Law School of Columbian University, has been elected president of the institution.

Mr. Alexander C. Humphreys has been elected president of the Stevens Institute of Technology, in succession to the late Henry Morton. Mr. Humphreys is a gas engineer and an alumnus and trustee of the institute.

The McGill University medical faculty has recommended the Board of Governors to appoint Dr. R. F. Ruttan as professor of chemistry, in succession to Dr. Girdwood, resigned, and Professor McBride, Strathcona professor of zoology in the arts faculty, to a like chair in the medical faculty.

At Cornell University Dr. H. Ries has been appointed to an assistant professorship in geology, and Dr. P. A. Fish to an assistant professorship in comparative physiology.

At the University of Colorado, in Boulder, Mr. H. Chester Crouch, of Oswego, New York, a graduate of Cornell University, has been appointed assistant professor of mechanical engineering in charge of the department. President James H. Baker has leave of absence for four months, during which time he will travel in Europe. Dr. Francis Ramaley, of the department of biology, will be acting president until his return.

Mr. Edward Gordon Duff, M.A., Oxford, of Wadham College, has been elected Sandars reader in bibliography at the University.

Mr. Charles G. Barkla has been elected to the Oliver Lodge fellowship, recently founded at University College, Liverpool, to promote research in physics.

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